SEP 3 1946

ELECTRONIC INDUSTRIES

September • 1946

IN THIS ISSUE:

INSTRUMENTATION APPLICATIONS

Production Aids that Are Speeding Up Operations and Stabilizing Quality • Summarizing Modern Methods of Using Today's Electronic Control Equipment • Utilizing the Dependability of Vacuum Tubes

MEASUREMENT AND RECORDING

Standards of Accuracy and Speed Improved with Latest Precision Instruments • The Use of Bolometers in High Sensitivity Temperature Measurements • Applications of Cathode Ray Tubes to Industrial Operations • Instrumentation for Atom Bomb Tests

ENGINEERING AND DESIGN

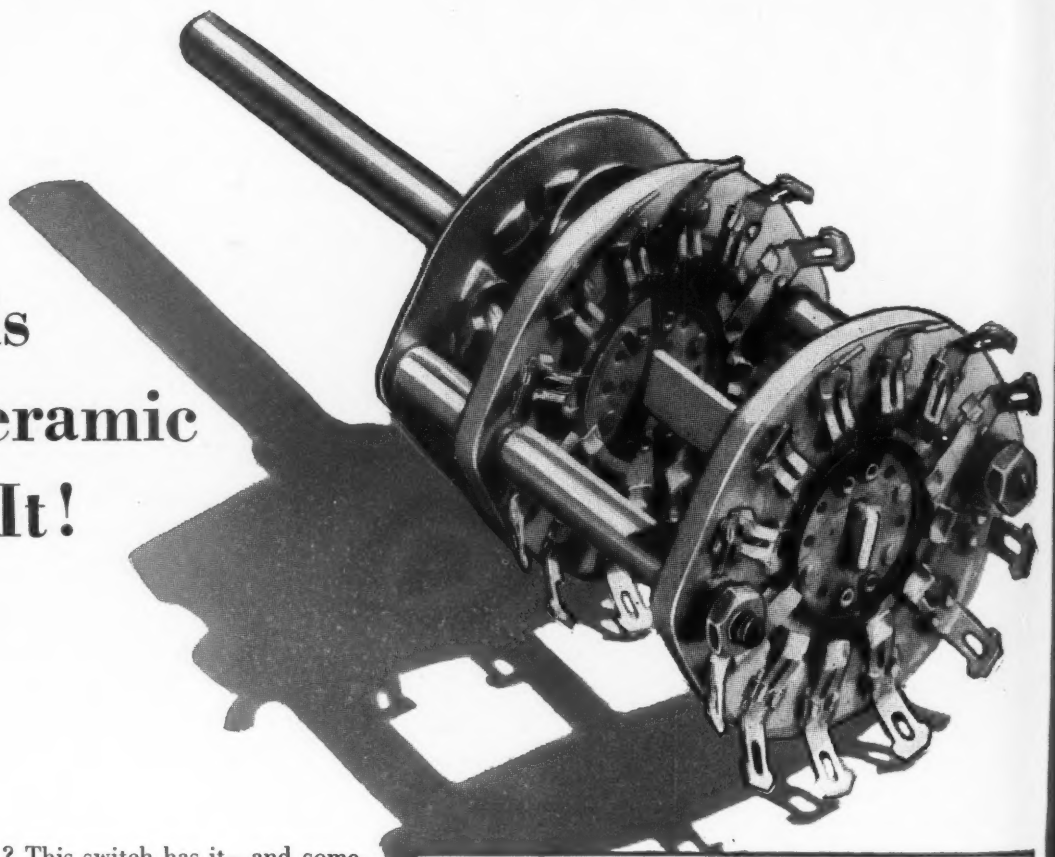
Probable Developments in Electronic Instrumentation • What Key Industries Expect in New Equipment • Design of Pulse Counting Units • Latest Offerings of Instrument Makers

INSTRUMENTATION CHART SUPPLEMENT WITH THIS ISSUE

CALDWELL-CLEMENTS, INC.

Need a Switch with
Maximum Insulation?

This RS 30 Ceramic Has It!

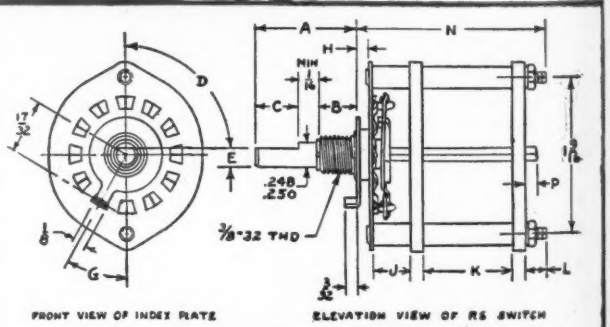


HIGH INSULATION? This switch has it—and something to spare! The ceramic rotors and stators are extra thick, too, for strength and durability.

But maximum insulation would mean very little were it not also coupled with these other advantages:

Compact design . . . Unlimited circuit possibilities . . . Silver-to-silver contacts . . . Double wiping contacts . . . New type rotor support allowing improved rotor and contact alignment . . . Indium-treated, silver plated rotor segments.

Want more details? Send for RS Switch Data Folders and for Specification Layout Sheets. If special help is required, our engineers will be glad to assist you. Standard Mallory Switches may be readily obtained from your Mallory Distributor.



FRONT VIEW OF INDEX PLATE — ELEVATION VIEW OF RS SWITCH

Ask for RS Specification-Layout Sheets

Printed on thin paper to permit blueprinting, these sectional drawings indicate standard and optional dimensions—make it easy for you to order pre-production samples of RS switches built to meet your requirements exactly. Ask your nearest Mallory Field Representative or write direct for a supply.

P. R. MALLORY & CO., Inc.

MALLORY SWITCHES

(INDUSTRIAL AND ELECTRONIC)

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

ELECTRONIC INDUSTRIES

Including INDUSTRIAL ELECTRONICS

Editorial Contents

SEPTEMBER, 1946

EDITORIAL 65

Instrumentation Chart—Electronic Toughness—500-kw Broadcast Stations—Electronic Microfilm Library

INDUSTRY STUDIES CIRCUIT TECHNICS..... 66

Modernized circuits and methods of utilizing electronic effects provide solutions to jobs in many fields

ELECTRONIC GAGING, Paul H. Hunter..... 68

New standards of accuracy and speed in dimensional inspection made possible by electronic instruments

SELECTING PROPER TUBES AND CIRCUITS.... 72

Survey of factors which must be considered in order to design reliability and long life into equipment

TELEMETERING FOR PROJECT CROSSROADS.. 76

Dr. J. W. Colton

Engineering the elaborate pressure measuring equipment used to record results of Bikini atom bomb tests

VACUUM TUBES IN INSTRUMENTATION..... 80

R. R. Batcher

Electronic devices heretofore used in industry to duplicate and sensitize other controls, do new jobs

ELECTRONIC TRUE DECADE COUNTERS..... 82

H. Gregory Shea

Advances in original Eccles-Jordan flip-flop circuit open the field of counter circuits to industry

WHAT INDUSTRY SEEKS IN ELECTRONIC CONTROL 85

Engineers of chemical, petroleum and food producers outline processing problems and instrument needs

THERMAL DETECTORS 87

Newest temperature instruments having extreme sensitivity find numerous uses in industry

RADIOACTIVITY METER, Arthur G. Bousquet... 88

Electronic engineering makes another contribution to development of atomic energy for constructive use

NEW INSTRUMENTATION PRODUCTS 90-95 and 106-108-110

NEW OSCILLOSCOPE DESIGN 98

Elmer C. Simmons

Recent circuits derived from radar research are combined in a new instrument for laboratory use

TUBES ON THE JOB..... 98

Mobile Radio for Trucks—Rubber Weighing—Electronic Wheel Balancing Equipment—Coin Rejector—Stress Measurements on Steel Trusses

SURVEY OF WIDE READING..... 100

Magnetically-Controlled Gas Discharge Tubes—Reproducing Sound Film—Powdered Iron Cores—Non-Linear Bridge Circuits as Voltage Stabilizers

NEW PATENTS ISSUED..... 102

Washington News..... 104

Television Today..... 112

News of Industry..... 114

New Books Reviewed..... 140

Personnel 142

New Bulletins..... 146

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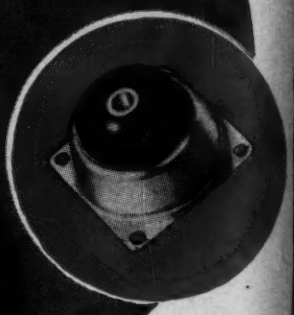
BRANCH OFFICES—Chicago 6, R. Y. Fitzpatrick, 201 N. Wells St., RAN 9225; Cleveland 14, D. J. O'Rourke, Citizens Bldg., 850 Euclid Ave., Main 8270; The Robert W. Walker Co., 684 So. Lafayette Park Pl., Los Angeles 14, VAndike 9348; San Francisco 4, 68 Post St., Sutter 5568.

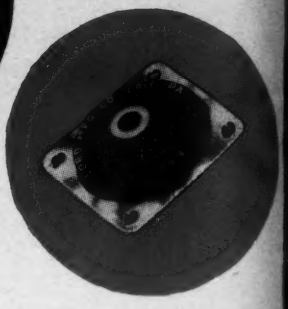
Vibration

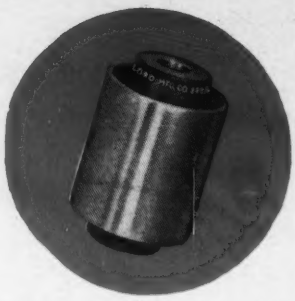
LOWERS WORKERS' MORALE
SHORTENS MACHINE LIFE
INCREASES REJECTS
CUTS YOUR PROFITS

Control it with



LORD
SHEAR TYPE
Bonded Rubber
MOUNTINGS





"VIBRATION nerves" are not the only cause of industrial fatigue, but they are a sure cause . . . and controllable, because vibration is controllable. Lord, pioneer in vibration control, has made better working conditions for hundreds of manufacturers, with consequent improved morale, increased output, and lowered employee turnover.

Machines, as well as men, are vulnerable to the destructive forces of vibration. Vibration control improves the quality of the machine's output, lowers maintenance cost, and greatly extends its useful life.

Vibration control is a necessary preliminary to quality control. Better workers and smoothly functioning machines are reflected immediately in the inspector's report of fewer rejects. It all points up to the prime objective of all industrial effort—increased profits.

Lord-engineered vibration control in your plant is a small investment with large and far-reaching returns. Write for Bulletin 104.

Every genuine Lord Mounting carries the name "LORD" embossed in the rubber or in raised letters on the forgings.

IT TAKES **BONDED RUBBER** *In Shear* TO ABSORB VIBRATION

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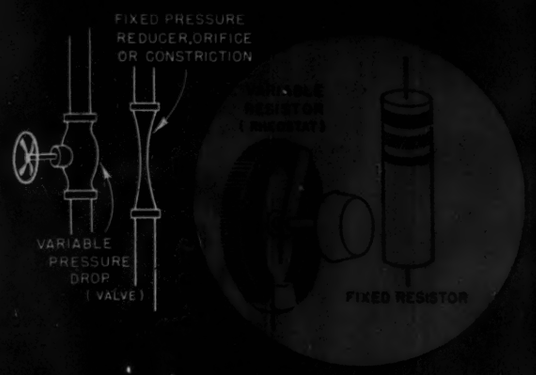
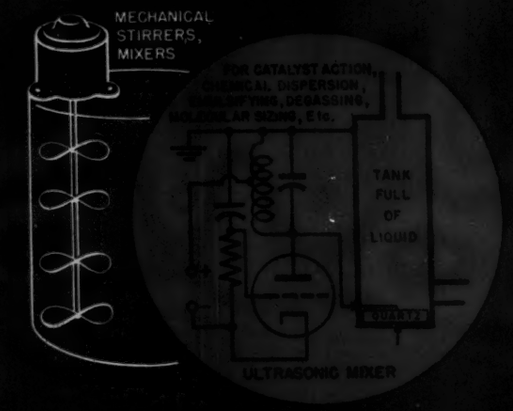
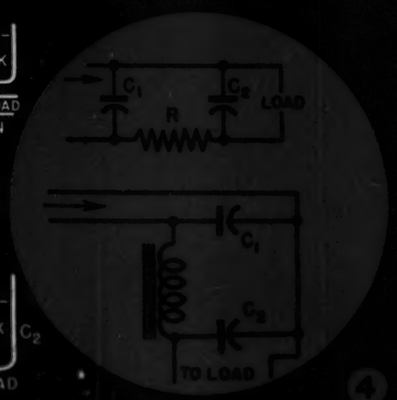
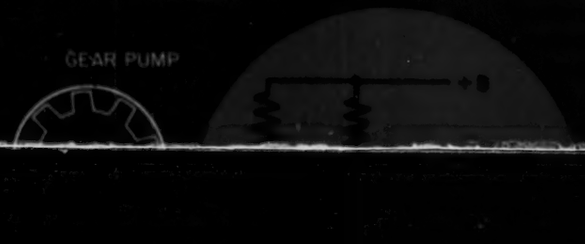
RAILWAY & POWER ENGINEERING CORP. LTD.
TORONTO, CANADA

Originators of Shear Type Bonded Rubber Mountings




MECHANICAL STIRRERS, MIXERS
FOR CATALYST ACTION, CHEMICAL DISPERSION, EMULSIFYING, DEGASSING, MOLECULAR SIZING, ETC.
TANK FULL OF LIQUID
QUARTZ
ULTRASONIC MIXER





ELECTRICAL

QUANTITY	COMMON UNIT		DIMENSIONS	INTERRELATIONS
ENERGY	KILOWATT HRS.	KWH	ml^2t^{-2}	POWER X TIME; CHARGE x e.m.f
POWER	WATTS	W	ml^2t^{-3}	CURRENT x emf
POTENTIAL	VOLTS	E	$m^{\frac{1}{2}}l^{\frac{1}{2}}t^{-1}\epsilon^{\frac{1}{2}}$	RESISTANCE x CURRENT
POTENTIAL GRADIENT	VOLTS/INCH		$m^{\frac{1}{2}}l^{-\frac{1}{2}}t^{-1}\epsilon^{\frac{1}{2}}$	
CHARGE	COULOMBS	Q	$m^{\frac{1}{2}}l^{\frac{3}{2}}t^{-1}\epsilon^{\frac{1}{2}}$	CURRENT x TIME
LINKAGES	WEBER-TURNS	$n\phi$	$m^{\frac{1}{2}}l^{\frac{1}{2}}\epsilon^{-\frac{1}{2}}$	CHARGE x RESISTANCE
CURRENT	AMPERES	I	$m^{\frac{1}{2}}l^{\frac{3}{2}}t^{-1}\epsilon^{\frac{1}{2}}$	emf/RESISTANCE
CURRENT DENSITY	AMPS/CM^2		$m^{\frac{1}{2}}l^{-\frac{1}{2}}t^{-2}\epsilon^{\frac{1}{2}}$	
TIME	SECONDS	t	t	
FREQUENCY	CYCLES/SEC	f	t^{-1}	
INDUCTANCE	HENRIES	H	$l^{-1}t^2\epsilon^{-1}$	VOLTS PER AMP. PER SEC.
CAPACITANCE	MICROFARADS	μF	$l\epsilon$	COULOMBS PER VOLT
RESISTANCE	OHMS	R	$l^{-1}t\epsilon^{-1}$	VOLTS/AMPERE
RESISTIVITY	OHMS / CM	p	$t\epsilon^{-1}$	
REACTANCE	OHMS	X	$l^{-1}t\epsilon^{-1}$	
CONDUCTANCE	MHOS	1/R	$t^{-1}\epsilon$	

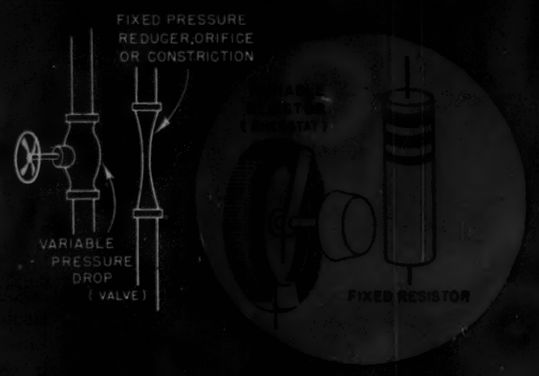
MECHANICAL

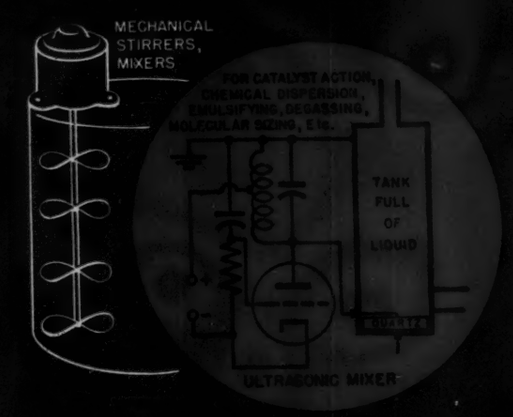
QUANTITY	COMMON UNIT		DIMENSIONS	INTER RELATIONS
ENERGY	FOOT LBS.	ft lb	ml^2t^{-2}	POWER x TIME; FORCE x DISPLACEMENT
POWER	HORSE POWER	HP	ml^2t^{-3}	FORCE x VELOCITY
FORCE	POUNDAL	ℓb	$ml\,t^{-2}$	MASS x ACCELERATION
PRESSURE	POUNDAL/IN^2	PSI	$ml^{-1}t^{-2}$	FORCE PER UNIT AREA
DISTANCE	FEET	ft	l	DISPLACEMENT * VELOCITY x TIME
MOMENTUM	Ft. lb/sec	M	$ml\,t^{-1}$	MASS x VELOCITY; DISPLACEMT. x DAMPING
VELOCITY	Ft./sec	v	$l\,t^{-1}$	DISPLACEMENT PER UNIT TIME
TIME	SECONDS	t	t	
FREQUENCY	CYCLES/SEC	f	t^{-1}	CYCLES PER UNIT TIME
MASS	POUNDS	ℓb	m	MOMENTUM / VELOCITY
COMPLIANCE		C	$m^{-1}t^2$	DISPLACEMENT / FORCE
DAMPING		D	$m\,t^{-1}$	COEFF. FRICTION X WEIGHT / VELOCITY
REACTANCE		X	$m\,t^{-1}$	

THERMAL

COMMON UNIT		DIMENSION
BRITISH THERMAL UNITS	BTU	ml^2t^{-2}
BTU PER HOUR	$\dot{q}$	ml^2t^{-3}
TEMPERATURE	°F	T
TEMP. GRADIENT	°F/ft	$T\,l^{-1}$
DISTANCE	FEET	l
THERMAL CURRENT		ml^2t^{-3}
THERMAL CURRENT DENSITY	H	mt^{-3}
TIME	hr	t
CYCLES		t^{-1}
SPECIFIC HEAT	S	$l^2t^{-2}T^{-1}$
THERMAL OHMS (THOHMS)	R	$T\,m^{-1}t^3$
COEFF OF HEAT TRANSFER	U	$T^{-2}mt^{-3}$
THERMAL CONDUCTIVITY	k	$T^{-1}mlt^{-3}$

INDUSTRIAL ELECTRONIC MEASUR

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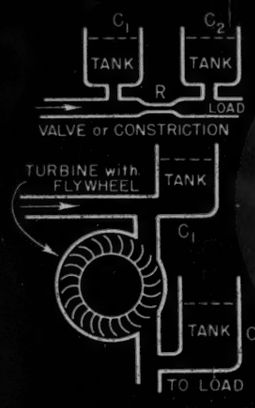
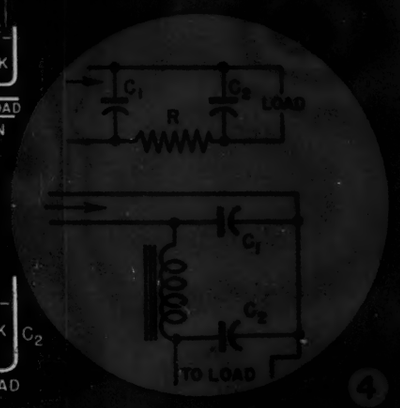




ELECTRICAL

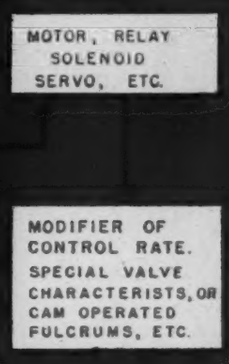
QUANTITY	COMMON UNIT		DIMENSIONS	INTERRELATIONS
ENERGY	KILOWATT HRS.	KWH	ml^2t^{-2}	POWER X TIME; CHARGE x e m f
POWER	WATTS	W	ml^2t^{-3}	CURRENT x emf
POTENTIAL	VOLTS	E	$m^{\frac{1}{2}}l^{\frac{1}{2}}t^{-1}\epsilon^{-\frac{1}{2}}$	RESISTANCE X CURRENT
POTENTIAL GRADIENT	VOLTS/INCH		$m^{\frac{1}{2}}l^{-\frac{1}{2}}t^{-1}\epsilon^{-\frac{1}{2}}$	
CHARGE	COULOMBS	Q	$m^{\frac{1}{2}}l^{\frac{3}{2}}t^{-1}\epsilon^{\frac{1}{2}}$	CURRENT x TIME
LINKAGES	WEBER-TURNS	$n\phi$	$m^{\frac{1}{2}}l^{\frac{1}{2}}\epsilon^{-\frac{1}{2}}$	CHARGE X RESISTANCE
CURRENT	AMPERES	I	$m^{\frac{1}{2}}l^{\frac{3}{2}}t^{-2}\epsilon^{\frac{1}{2}}$	emf/RESISTANCE
CURRENT DENSITY	AMPS/CM ^{2}		$m^{\frac{1}{2}}l^{-\frac{1}{2}}t^{-2}\epsilon^{\frac{1}{2}}$	
TIME	SECONDS	t	t	
FREQUENCY	CYCLES/SEC	f	t^{-1}	
INDUCTANCE	HENRIES	H	$l^{-1}t^2\epsilon^{-1}$	VOLTS PER AMP. PER SEC.
CAPACITANCE	MICROFARADS	μF	$l\epsilon$	COULOMBS PER VOLT
RESISTANCE	OHMS	R	$l^{-1}t\epsilon^{-1}$	VOLTS/AMPERE
RESISTIVITY	OHMS / CM	P	$t\epsilon^{-1}$	
REACTANCE	OHMS	X	$l^{-1}t\epsilon^{-1}$	
CONDUCTANCE	MHOS	1/R	$t^{-1}\epsilon$	

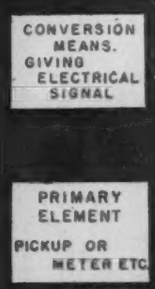
MECHANICAL

QUANTITY	COMMON UNIT		DIMENSIONS	INTERRELATIONS
ENERGY	FOOT LBS.	ft lb	ml^2t^{-2}	POWER x TIME; FORCE x DISPLACEMENT
POWER	HORSE POWER	HP	ml^2t^{-3}	FORCE x VELOCITY
FORCE	POUNDAL	ℓb	$ml\ t^{-2}$	MASS x ACCELERATION
PRESSURE	POUNDAL/IN ^{2}	PSI	$ml^{-1}t^{-2}$	FORCE PER UNIT AREA
DISTANCE	FEET	ft	l	DISPLACEMENT = VELOCITY x TIME
MOMENTUM	Ft. lb/sec	M	$ml\ t^{-1}$	MASS x VELOCITY; DISPLACEMNT. x DAMPING
VELOCITY	Ft. /sec	v	$l\ t^{-1}$	DISPLACEMENT PER UNIT TIME
TIME	SECONDS	t	t	
FREQUENCY	CYCLES/SEC	f	t^{-1}	CYCLES PER UNIT TIME
MASS	POUNDS	ℓb	m	MOMENTUM / VELOCITY
COMPLIANCE		C	$m^{-1}t^2$	DISPLACEMENT / FORCE
DAMPING		D	$m\ t^{-1}$	COEFF. FRICTION X WEIGHT / VELOCITY
REACTANCE		X	$m\ t^{-1}$	

THERMAL

COMMON UNIT		DIMENSION
BRITISH THERMAL UNITS	BTU	ml^2t^{-}
BTU PER HOUR	$\dot{q}$	ml^2t^{-}
TEMPERATURE	^oF	T
TEMP. GRADIENT	$^oF/ft$	$T\ l^{-1}$
DISTANCE	FEET	l
THERMAL CURRENT		ml^2t^{-}
THERMAL CURRENT DENSITY	H	mt^{-3}
TIME	hr	t
CYCLES		t^{-1}
SPECIFIC HEAT	S	$l^2t^{-2}T$
THERMAL OHMS (THOHMS)	R	$Tm^{-1}t$
COEFF OF HEAT TRANSFER	U	$T^{-2}mt^{-}$
THERMAL CONDUCTIVITY	k	$T^{-1}mlt^{-}$





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LINEAR	BY INTEGRA
LOGARITHMIC	BY DIFFEREN
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LIMITING OR COMPRESSION	TO SQUARE
EXPANDING	TO PULSES

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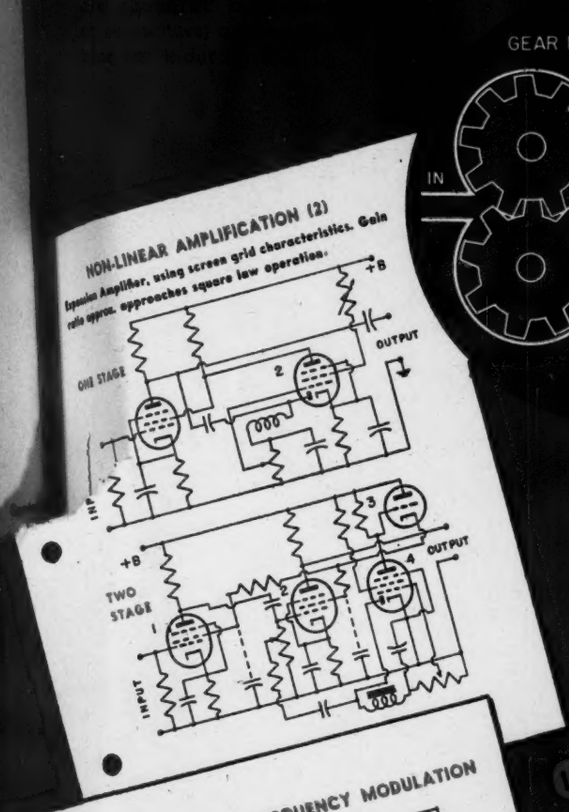

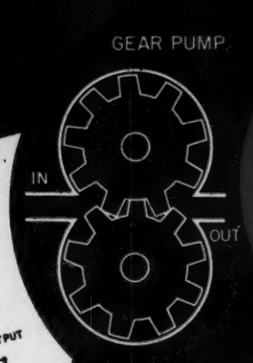

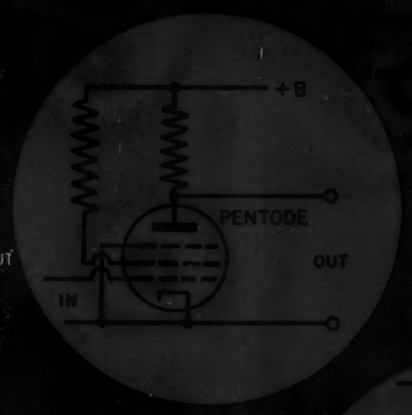

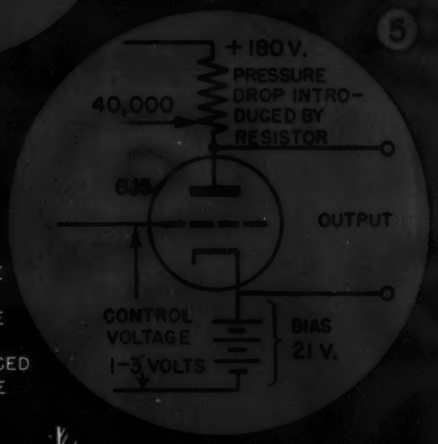

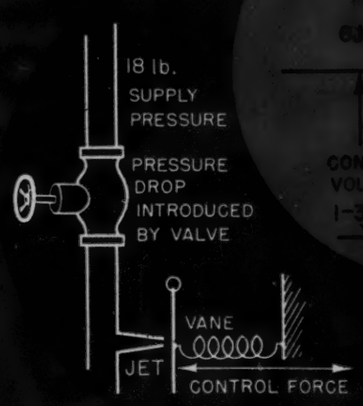

INDUSTRIAL ELECTRONIC MEASUR

Portraying Some of the Advances in the Instrumentation Field

An Electronic Device is one that uses vacuum tubes. The latter are char an evacuated space by the application of effects

1. **Rate of electron emission from cathode.** (Photoelectric tubes, Electron multipliers, Iconoscopes, etc.)
2. **Density of electron flow.** (Triodes, pentodes and other amplifier and oscillator tubes.)
3. **Direction of electron flow.** Magnetrons, Cathode ray tubes, Mass Spectr graphs, Electron micr scopes, etc.)

The electrons controlled in one of these ways may be passed into a circuit where th or they may be used to bombard a target and produce secondary electronic

COMPILED BY R. R. BATCHER OF "ELECTR

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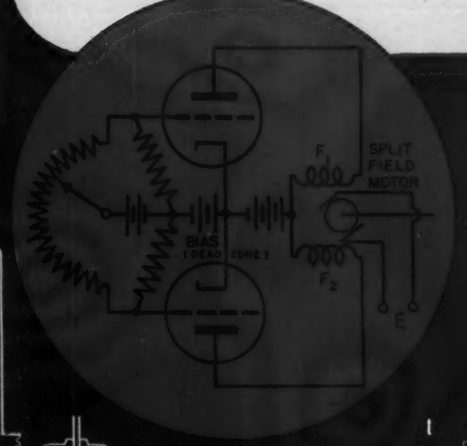
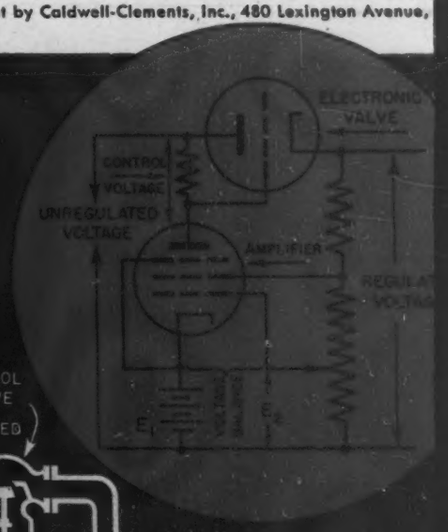
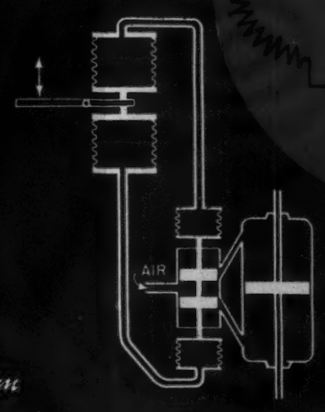
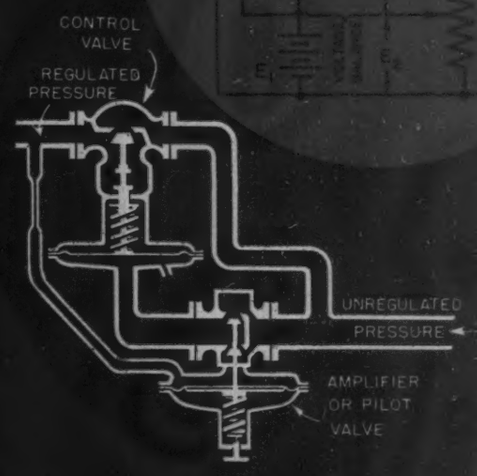
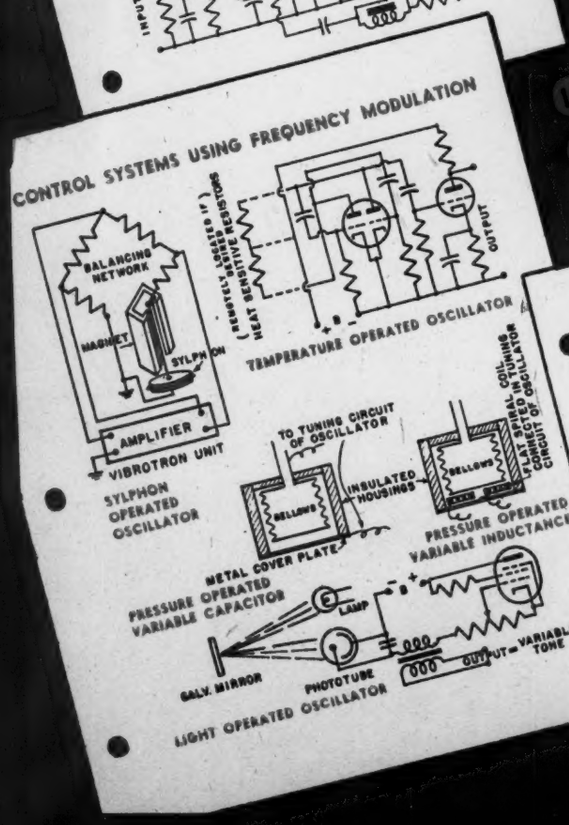
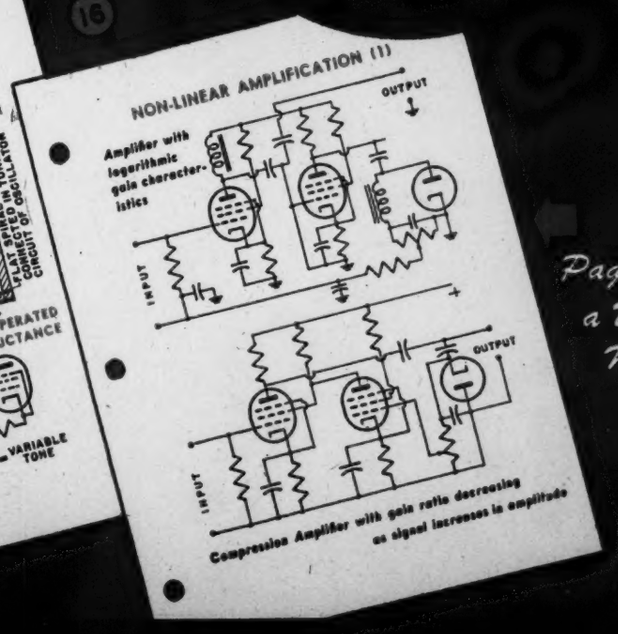






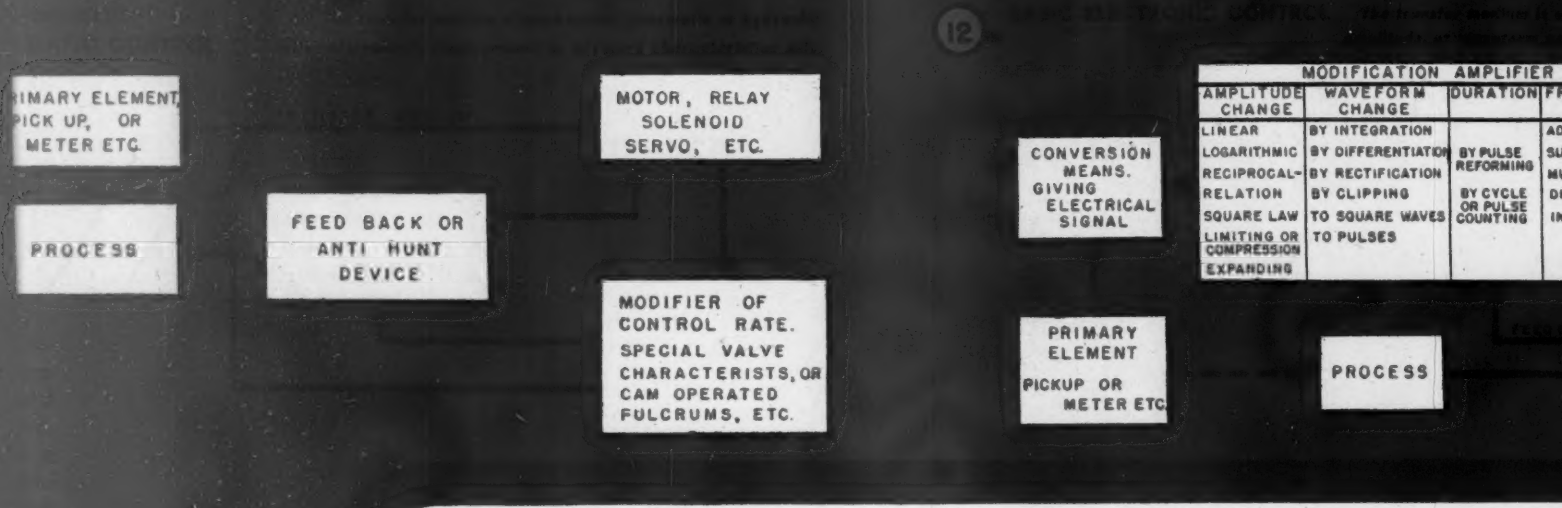





NON-LINEAR AMPLIFICATION (1)
Amplifier with logarithmic gain characteristics
OUTPUT
INPUT
Compression Amplifier with gain ratio decreasing as signal increases in amplitude

Pages from a Designer's Notebook

CAL			MECHANICAL				THERMAL			
	DIMENSIONS	INTERRELATIONS	QUANTITY	COMMON UNIT		DIMENSIONS	INTERRELATIONS	COMMON UNIT		DIMENSIONS	INTERRELATIONS
H	$m l^2 t^{-2}$	POWER x TIME; CHARGE x emf	ENERGY	FOOT LBS.	ft lb	$m l^2 t^{-2}$	POWER x TIME; FORCE x DISPLACEMENT	BRITISH THERMAL UNITS	BTU	$m l^2 t^{-2}$	MASS x TEMP
	$m l^2 t^{-3}$	CURRENT x emf	POWER	HORSE POWER	HP	$m l^2 t^{-3}$	FORCE x VELOCITY	BTU PER HOUR	q	$m l^2 t^{-3}$	BTU/hr
	$m^{\frac{1}{2}} l^{\frac{1}{2}} t^{-1} \epsilon^{\frac{1}{2}}$	RESISTANCE x CURRENT	FORCE	POUNDAL	ℓb	$m l t^{-2}$	MASS x ACCELERATION	TEMPERATURE	°F	T	T = RH
	$m^{\frac{1}{2}} l^{\frac{1}{2}} t^{-1} \epsilon^{\frac{1}{2}}$		PRESSURE	POUNDAL/IN^2	PSI	$m l^{-1} t^{-2}$	FORCE PER UNIT AREA	TEMP. GRADIENT	°F/ft	$T l^{-1}$	
	$m^{\frac{1}{2}} l^{\frac{1}{2}} t^{-1} \epsilon^{\frac{1}{2}}$	CURRENT x TIME	DISTANCE	FEET	ft	l	DISPLACEMENT = VELOCITY x TIME	DISTANCE	FEET	l	
ϕ	$m^{\frac{1}{2}} l^{\frac{1}{2}} \epsilon^{-\frac{1}{2}}$	CHARGE x RESISTANCE	MOMENTUM	Ft. lb/sec	M	$m l t^{-1}$	MASS x VELOCITY; DISPLACE'MT. x DAMPING				
	$m^{\frac{1}{2}} l^{\frac{1}{2}} t^{\frac{1}{2}} \epsilon^{\frac{1}{2}}$	emf/RESISTANCE	VELOCITY	Ft./sec	v	$l t^{-1}$	DISPLACEMENT PER UNIT TIME	THERMAL CURRENT		$m l^2 t^{-3}$	(SEE q)
	$m^{\frac{1}{2}} l^{\frac{1}{2}} t^{-2} \epsilon^{\frac{1}{2}}$							THERMAL CURRENT DENSITY	H	$m t^{-3}$	BTU/hr x ft^2
	t		TIME	SECONDS	t	t		TIME	hr	t	
	t^{-1}		FREQUENCY	CYCLES/SEC	f	t^{-1}	CYCLES PER UNIT TIME	CYCLES		t^{-1}	
	$l^{-1} t^2 \epsilon^{-1}$	VOLTS PER AMP. PER SEC.	MASS	POUNDS	ℓb	m	MOMENTUM / VELOCITY				
F	$l \epsilon$	COULOMBS PER VOLT	COMPLIANCE		C	$m^{-1} t^2$	DISPLACEMENT / FORCE	SPECIFIC HEAT	S	$l^2 t^{-2} T^{-1}$	BTU PER lb PER °F
	$l^{-1} t \epsilon^{-1}$	VOLTS/AMPERE	DAMPING		D	$m t^{-1}$	COEFF. FRICTION X WEIGHT / VELOCITY	THERMAL OHMS (THOHMS)	R	$T m^{-1} t^3$	°F PER BTU/hr x ft^2
	$t \epsilon^{-1}$										
	$l^{-1} t \epsilon^{-1}$		REACTANCE		X	$m t^{-1}$					
R	$t^{-1} \epsilon$							COEFF OF HEAT TRANSFER	U	$T^{-2} m t^{-3}$	= $1/RT$
								THERMAL CONDUCTIVITY	k	$T^{-1} m l t^{-3}$	= l/R



INDUSTRIAL ELECTRONIC MEASUREMEN

Portraying Some of the Advances in the Instrumentation Field Introduced

An Electronic Device is one that uses vacuum tubes. The latter are characterized as an evacuated space by the application of effects that alter the

1. **Rate of electron emission from cathode.** (Photoelectric tubes, Electron multipliers, Iconoscopes, etc.)
2. **Density of electron flow.** (Triodes, pentodes and other amplifier and oscillator tubes.)
3. **Direction of electron flow.** Magnetrons, Cathode ray tubes, Mass Spectrographs, Electron microscopes, etc.)
4. **Electr Veloci** (Klystro modula

The electrons controlled in one of these ways may be passed into a circuit where they produce so or they may be used to bombard a target and produce secondary electronic emission or x-

COMPILED BY R. R. BATCHER OF "ELECTRONIC INDU

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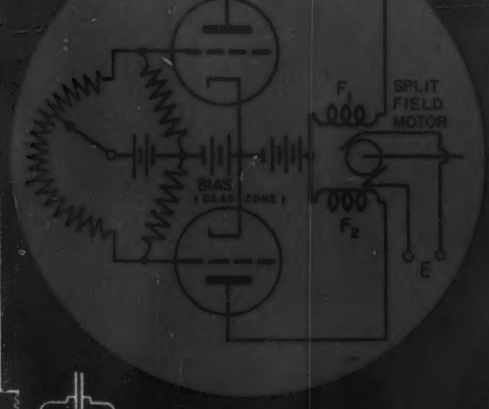
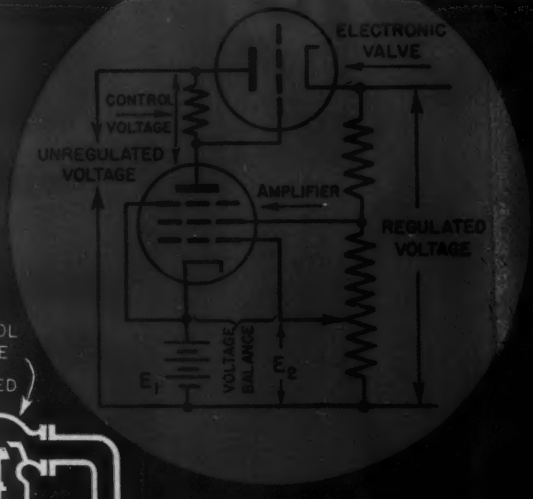
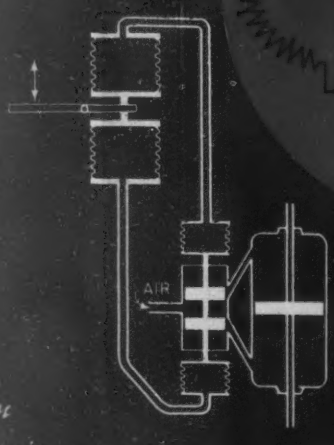
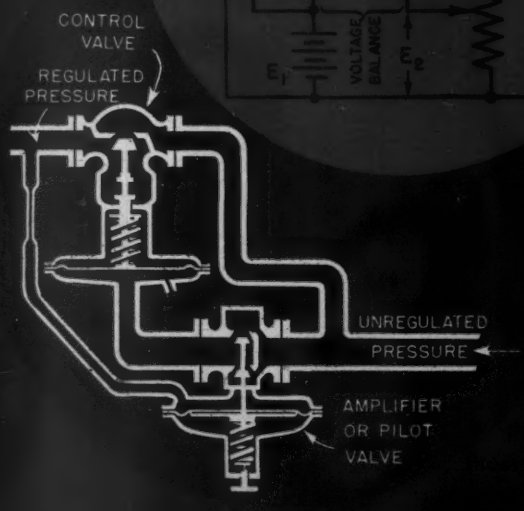








...es from Designer's Notebook

LATIONS	HYDRAULIC					MAGNETIC				
	QUANTITY	COMMON UNIT		DIMENSIONS	INTERRELATIONS	QUANTITY	COMMON UNIT		DIMENSIONS	INTERRELATIONS
TEMP	ENERGY	FOOT LBS.	E	ml^2t^{-2}	$= Hqt = HQ$	ENERGY	JOULES	E	ml^2t^{-2}	$= \mathcal{F}\phi$
hr	POWER	HORSE POWER	P	ml^2t^{-3}	$= Hq$	POWER	JOULES/SEC	P	ml^2t^{-3}	$= \mathcal{F}\phi/t$
RH	FORCE	POUNDALS	F	$ml\,t^{-2}$	$= Kq$	MAGNETO MOTIVE FORCE	AMPERE TURN	$\mathcal{F}$	$m^{\frac{1}{2}}l^{\frac{3}{2}}t^{-2}\epsilon^{\frac{1}{2}}$	$= \mathcal{R}\phi$
	PRESSURE(HEAD)	POUNDALS IN^2	H	$ml^{-1}t^{-2}$	$= r \times$ FLOW DENSITY	MAGNETIZING FORCE	AMP. TURN/cm	H	$m^{\frac{1}{2}}l^{\frac{1}{2}}t^{-2}\epsilon^{\frac{1}{2}}$	
	QUANTITY	CUBIC FEET	Q	l^3	$= CH$					
q_f)	DISCHARGE	Ft ^{3}/SEC.	q_f	l^3t^{-1}	$= F/r$	FLUX	WEBERS	ϕ	$m^{\frac{1}{2}}l^{\frac{1}{2}}\epsilon^{-\frac{1}{2}}$	$= \mathcal{F}/\mathcal{R}$
r×ft^2	FLOW DENSITY	Ft ^{3}/SEC.xIN^2		lt^{-1}		INDUCTION	WEBERS/cm^2	$\mathcal{B}$	$m^{\frac{1}{2}}l^{-\frac{1}{2}}\epsilon^{-\frac{1}{2}}$	$= \mu H$
	TIME	SECONDS		t		(TIME)	(SECONDS)	t	t	
ER lb OF	CAPACITY		C	$m^{-1}l^4t^2$	$= E/H^2 = Q/H$					
BTU ft^2	RESISTANCE *		r	$ml^{-2}t^{-1}$		RELUCTANCE	AMP TURNS / WEBER	$\mathcal{R}$	$lt^{-2}\epsilon$	$= \mathcal{F}/\phi$
	VISCOSITY	POISE	μ	$ml^{-1}t^{-1}$	$= rl$	RELUCTIVITY	AMP TURNS/ WEBER/cm	μ^{-1}	$l^2t^{-2}\epsilon$	$= H/\mathcal{B}$
						PERMEANCE	WEBERS / AMP TURN	$\mathcal{P}$	$l^{-1}t^2\epsilon^{-1}$	$= \phi/\mathcal{F} = \mu A/l$
/RT						PERMEABILITY		μ	$l^{-2}t^2\epsilon^{-1}$	$= \mathcal{B}/H$
l/R	* A FUNCTION OF VELOCITY, VISCOSITY ETC.									

LIFIER TION	FREQUENCY SHIFT
LSE RMING	ADDITION
	SUBTRACTION
YCLE ULSE TING	MULTIPLICATION
	DIVISION
	INVERSION

REMOTE OR LOCAL INDICATORS OR RECORDERS

POWER AMPLIFIER

RELAY, MOTOR SOLENOID OR OTHER RESTORING MEANS

ENT & CONTROL

uced by Vacuum Tube Circuits

ed as utilizing electrons controlled in
er the : ———

Electron Velocity.
(Klystrons, Velocity modulated tubes.)

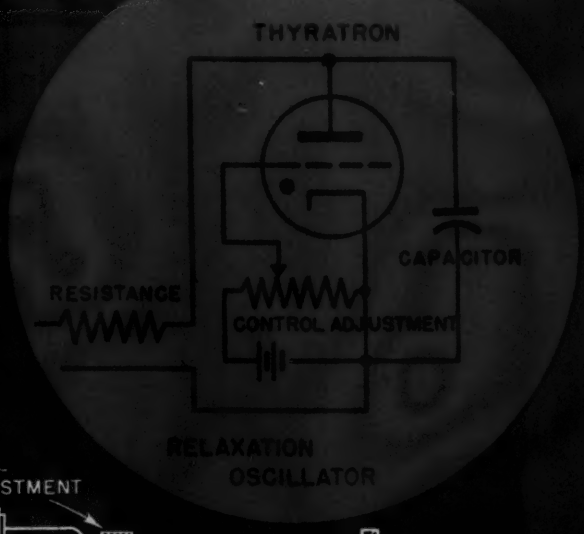
5. Electronic Path length across the space. (Tubes with a movable element.)

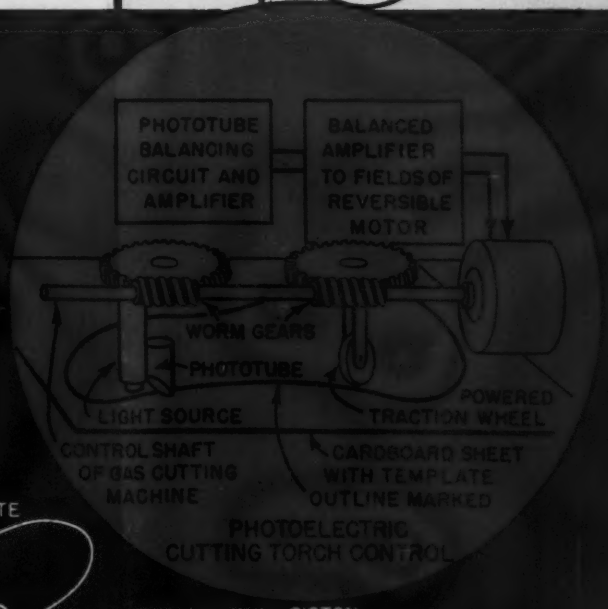
ce some type of electrical manifestation, or x-rays, or fluorescent illumination.

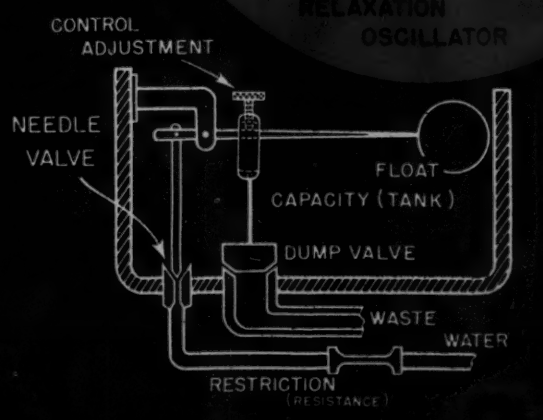
INDUSTRIES"
17, N. Y.

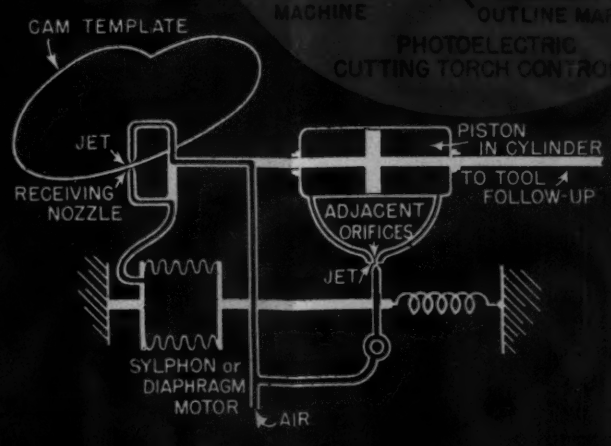
ELECTRON TUBE CIRCUIT FUNCTIONS

CONTROL VOLTAGE	TRIODE, PENTODE, ETC.	VARIABLE RESISTANCE	TWO INTERRELATED VOLTAGES	CATHODE RAY TUBE	TWO DIMENSIONAL PLOT OF THESE QUANTITIES
CONTROL VOLTAGE	TRIODE, PENTODE, ETC.	AMPLIFIED VOLTAGE	CONTROL VOLTAGE	PENTODE	VARIABLE IMPEDANCE (INDUCTANCE OR CAPACITANCE)
ELECTRONS	ELECTRON MULTIPLIER	VOLTAGE	SMALL CONTROL VOLTAGE	STROBOTRON OR DISCHARGE TUBE	BRILLIANT LIGHT FLASH
ALTERNATING CURRENT	RECTIFIER	DIRECT CURRENT	TWO DIFFERENT FREQUENCIES	MIXER OR CONVERTER TUBE	OUTPUT SUM OR DIFFERENCE OF THE TWO FREQUENCIES
DIRECT CURRENT POWER	OSCILLATOR	ALTERNATING CURRENT POWER	ALTERNATING CURRENT	HARMONIC GENERATOR	HARMONICS OF THAT ALTERNATING CURRENT
LIGHT	PHOTOTUBE	VOLTAGE OR RESISTANCE	SMALL CONTROL VOLTAGE	THYRATRON OR IGNITRON	SWITCH FOR HEAVY CURRENTS
ILLUMINATED SCENE	ICONOSCOPE ORTHICON, ETC.	SUCCESSIONS OF SCANNED ELECTRICAL EQUIVALENTS	UNSTEADY VOLTAGES	REGULATOR TUBE OR CIRCUIT	CONSTANT VOLTAGE




PHOTOTUBE BALANCING CIRCUIT AND AMPLIFIER
BALANCED AMPLIFIER TO FIELDS OF REVERSIBLE MOTOR
WORM GEARS
PHOTOTUBE
LIGHT SOURCE
POWERED TRACTION WHEEL
CONTROL SHAFT OF GAS CUTTING MACHINE
CARDBOARD SHEET WITH TEMPLATE OUTLINE MARKED
PHOTOELECTRIC CUTTING TORCH CONTROL





INDUSTRY STUDIES

Modernized circuits and methods of utilizing electronic effects provide solutions to difficult jobs in many specialized fields

• During the past five years the need for better, faster and more accurate controls for military units caused a re-evaluation of some of the operating principles in many fields, with the result that electronic methods have made great strides. The old argument against using "fragile" tubes in an important control arrangement has been shattered by the accumulated weight of evidence: tubes able to withstand 20,000 g's in any direction when installed within gun-fired missiles, and tubes having an extended life that permits their continuous service underground or under water, where replacement is tedious and expensive; tubes with notable stability of operating characteristics and others whose sensitivity is advanced to a point where it is no longer necessary or desirable to "push" them to their amplification limits.

The military procurement personnel was not influenced by the awe with which tubes often have heretofore been considered by industrial users. In some cases in the latter field even a single phototube or a simple amplifier was regarded with misgivings. Tubes now are used by the hundreds in a single equipment and have no more glamour than dry cells.

In applying electronic elements to equipment in the field of industrial process control, it is found practicable to "build in" any desired relation between cause and effect, by simple variations of a circuit. It is possible to anticipate and avoid a change, even before it makes itself evident to the primary measuring element, by simply watching all of the main causes for changes, noting variations in loads, temperatures, flow rates, heads, etc., and by the use of mixing circuits to give a positive correction in some particular controlling factors.

Manual control methods are complicated in some processes. For example, it may be necessary to turn A to the right if both B is above a value X and C is less than level Y. This is probably a simple form of instructions to an operator but when the process is six or ten times as complicated, the job is hopeless with manual control. For this reason industrial instrumentation has become a science. It has been the major factor permitting the establishment of continuous production methods.

WHERE ELECTRONIC CONTROL TECHNICS ARE EXPANDING

(1) Frequency modulated signals as a transfer medium.
(2) Pulse technics, and the adaptation of Radar principles.
(3) Amplifiers with gain characteristics following prescribed curves.
(4) Driftless amplifiers that handle slowly varying or steady state levels.
(5) Applications of scanning principles.
(6) Two dimensional recording of correlated effects.
(7) Feedback principles with prescribed characteristics.
(8) Generators of ultrasonic power.
(9) Increased precision of measurements with negligible loading effect by use of a measuring "probe".
(10) Reduction of measuring lag, by amplifying the output from smaller, less sensitive primary elements.
(11) Utilization of absorption loss measurements and attenuation to study physical characteristics giving non-destructive test methods.
(12) High speed counting circuits.
(13) Ratio and multiple source control circuits.
(14) Time-variable control, and the utilization of time as the control factor.
(15) Mathematical computing circuits, ranging from simple integrating or differentiating arrangements to elaborate computing systems.

Control fundamentals

Industrial control consists fundamentally of regulating or keeping at level value, some inherent quality in a process which normally would vary because of changes in the flow rates or characteristics of the factors in the system. Many instrumentation methods are complicated, sometimes because in the usual design procedure use has been made of elements in the system whose characteristics are far from ideal. There can be noted throughout many of the fundamental pneumatic and hydraulic systems where inverse relations, and nonlinear operating characteristics come up with great regularity. Because of this a whole series of complicated procedures has come about to meet the need for auxiliary correcting elements to make up for characteristic deficiencies in some parts of the system. These range from nonlinearities in the pick-up elements to the actual flow characteristics of the valves, pipes, etc.

In some instrumentation systems, designers have had to cure process variations in much the same manner that a doctor caught with only quinine, sulphur and castor oil at hand, would use. He would have to use one alone or else some combination as he saw fit. Similarly the designer might pick a system having some "floating" control and some "proportional" control with maybe a dash of "rate" added. However, if the combination were selected intelligently good results would be obtained. It may be of interest to note, however, that these

New CIRCUIT TECHNICS

WHY ELECTRONIC CONTROL IS GAINING IN POPULARITY

(1) Electrical signal or control lines are easy to install.

(2) Speed of response high, and essentially unaffected by distance.

(3) Only method by which complete centralization of controls and indicators can be achieved.

(4) Quantities and levels can be checked readily at various points in system using simple, accurate electrical indicators.

(5) Time, force, displacement and positional information can be converted readily to signal amplitude variations and vice versa.

(6) Simple electrical networks can be used to modify the control signal to obtain inverse functions, derivatives, etc.

(7) Provides simple means for combining effects of several diverse primary variables, by addition, multiplication or subtraction, with different weighting factors for each if desired.

(8) Permits unlimited number of gradation steps of control.

(9) Control signal is easily applied to modulate radio signals, for remote operation.

(10) Components of circuits are usually combinations of standard parts.

(11) No piping to develop leaks with aging, vibration, etc.

(12) High impedance, low current circuits are widely used, eliminating chances of sparking and explosions, as when electrical controls are used.

On the other hand, Pneumatic, Hydraulic and Mechanical systems have proved useful because they are:

(1) Established by precedent in existing jobs. Operating experience and long use often make their continued use desirable.

(2) Explosion proof (no sparking).

(3) Capable of delivering high power operating and control forces.

effects or their equivalents have not been separately considered in electronic circuits except when it was desired to duplicate existing methods of control.

Following normal design procedure in communication circuits would be to compare the information delivered by the pickup element with the characteristics delivered by the final correcting regulator, and then to develop an amplifier that would deliver power to the latter in accordance with a desired operating curve.

In addition to the possibility of correcting for variations in intermediate effects and the final activator's operating characteristics, the electronic designer can take note of process lags of certain types and thus anticipate the effect of the applied corrective. As an example, in a plant where an unusually long transfer lag was present, a circuit was operated by two suitably placed primary elements (connected in opposition and spanning the capacity that introduced the lag) which thus altered the rate in accordance with the temperature difference.

Examples such as these show why some electronic circuits contain so many tubes. However, once the electronic system is selected and the basic chassis and power sources are provided, it is not particularly difficult or expensive to add refinements in operation that require an additional tube or so.

With so many obvious features it may be asked why electronic methods have not replaced all other control methods and the thought occurs to many that something must be wrong with the basic principles upon which they function.

It seems to this writer that the know-how in the installation and operation of the earlier non-electronic control systems is firmly established, and, what is probably more important, the development and promotion of electronic systems have been left to process control equipment companies and instrument companies serving those fields.

Electronic equipment manufacturers themselves have for the most part placed hopes heretofore in selling "packaged" items that they thought would have some appeal to a wide variety of industries. These have most generally failed to create more than passing interest, because (1) the electronic "gadget" failed to operate existing motorized or solenoid operated valves, etc., (2) the specialized items that are intermediate between the electronic instrument and the process were inadequate or even unavailable, (3) the difficulty of adapting universal, or "packaged" items to the particular requirements of the individual jobs was unsolved by either the equipment manufacturer or even the instrument department of the plant because of the lack of sufficient data on the loading characteristics to permit an intelligent selection of the auxiliaries.

Electronic alternates

This state of affairs is changing of late and along several lines. Many old line instrument companies are building up electronic "alternates" to some of their mechanical systems, and in addition many companies that have developed and manufactured intricate control systems for military uses, are now working on industrial equivalents for some of the seemingly useful arrangements. Then again, some of the larger industrial plants which have relied on the reports of electronically-minded individuals or committees to point out useful possibilities, have now been able to retain radio or electronic engineers to follow up suggestions and to develop solutions to some of the important problems.

If this engineer knows tubes and their circuits (and the usual process control problem requires greatly different technics than would be found with high frequency communication services) and is either acquainted with or can get the required process information from associates, he will be able to select or develop what is needed to han-

(*Continued on page* 122)

ELECTRONIC GAGING

By **PAUL H. HUNTER**
Instrumentation Editor—ELECTRONIC INDUSTRIES

New standards of accuracy and speed in dimensional inspection made possible by precision electronic instruments

• The usual instruments for measuring thickness or diameters are the caliper, hand micrometer, dial indicator, etc. All these devices seek to transfer sensory perception from touch to vision, the latter having much the greater range. Instruments for precision gaging are of two general types: those having a *measuring* function and those serving mainly as *comparators*. To perform a measuring function, an instrument must be calibrated in terms of some dimensional unit, whereas the comparison function requires only an indication that the piece being gaged is larger or smaller than a reference standard. Comparison instruments achieve maximum accuracy when the sample compared is identical with the standard of comparison. The accuracy of deviation indication from the standard dimension is a function of the stability at which the magnification ratio is maintained, this magnification being ordinarily performed by mechanical means, such as a calibrated screw, or a rack and pinion with high gearing ratio, as in the standard dial gage.

The shortcomings of such gages are well known. The need for contact pressure on the work, in order to determine the "feel" of the instrument, is one variable factor. Dial gages and other instruments depending upon mechanical magnification through a multiplicity of gears, racks, pinions and the like, have numerous points of wear and sources of error, particularly when one instrument must be used over a wide range of dimension. Even with the use of jewel bearings, friction due to mechanical amplification and other factors limits accuracy to about 1/10,000th in. for practical purposes.

Many attempts have been made to reduce weight and friction components by means of light beams. However, even with monochromatic light, the practical length of such a beam is about four feet, due to dispersion of single wavelengths of light beyond that point. Another method that extends accuracy by optical methods uses the interferometer to measure the distortion of a cantilever bar bearing on the workpiece. Though increasing scale length considerably, pressure on the work has not been reduced sufficiently for the measurement of soft materials. Instruments such as those developed by Van Keuren have achieved accuracies approaching one-half the wavelength of green light (about 10 micro-inches). However, the determination of beam deflection depends on observation of interference fringes which are approximate sine functions of light intensity and therefore do not provide sharp reference points for measurement.

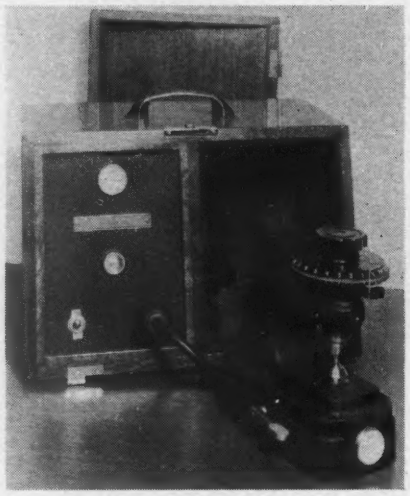


Fig. 1—Carson Electronic Micrometer (Model M)

The next step in the elimination of human observational error is the use of electronics. The basic limitation of light as an indicator can only be overcome by means of shorter wavelengths such as are characteristic of electron emission. This principle led to the development of the electron microscope which, while capable of the highest order of magnification, does not compete directly with small, portable instruments for rapid gaging.

Various types of electronic micrometers and comparators have been developed within the past few years in response to an urgent need for measuring instruments that will keep pace with the capabilities of modern tools and methods of production. Since space does not permit complete coverage of the entire range of electronic gaging, this discussion will be confined to two currently available types. Other developments in this field will be the subject of future articles.

Electronic micrometer

In the Carson Electronic Micrometer,[1] illustrated in Fig. 1, the setting of the gage head has been made independent of contact pressure or "feel" of any sort in order that repeated measurements of the same dimension by different operators will yield exactly the same result. In addition, the enormous sensitivity of grid-controlled high vacuum tubes has been utilized to extend the range of dimensional perception into regions where even the finest optical instruments are blind. The use of an electronic trigger circuit enables contact indications to be obtained on hard surfaces with absolutely no pressure on the work. The circuit proved adaptable also for measuring soft materials, such as felt or tissue paper, with controllable pressures up to a few ounces.

A requirement that developed as the result of experiments with this instrument was the elimination of all current flow at the point of contact with the work being measured. It was found that the presence of any current tended to build up carbonized layers on the micrometer contact surfaces which soon destroyed the accuracy of determining the moment of contact. These lay-

ers are equivalent to pressure-sensitive variable resistors. With continued use, increased pressures required to overcome the electrical resistance of these carbonized layers were found to cause a shift in the zero calibration of the indicator dial. The only satisfactory and complete solution to this difficulty was to reduce current at the moment of contact to zero.

The Carson electronic micrometer has a conventional micrometer screw of very high lead accuracy, with a special electronic circuit to indicate the precise instant of contact between the micrometer screw and the material being measured (the work). This permits the use of a large diameter dial on which each division of .0001 in. can be spaced widely enough for accurate interpolations down to 25 micro-inches, or less. The electronic circuit (shown in Fig. 2) lights an indicating lamp by means of a relay at the moment of contact. A displacement of 5 micro-inches is sufficient to trigger this relay. Since there is no current to be interrupted, there is no arcing or pitting and the contacts remain permanently clean without servicing.

In Fig. 3, note that the micrometer head is mounted in the upper arm, with an anvil clamped in the base. The head consists of an insulated micrometer screw and nut with a large, plastic dial and knob incorporating uniform scale divisions as part of the molding process. The lower anvil is removable for easy substitution of any special work support and may be retracted by the lever at the left of the base for easy insertion of the work. While most models of the instrument in current production are designed for pressureless contact, one model was deliberately provided with a standard anvil pressure of two ounces, sufficient to flatten various materials such as photographic film, paper, foils, textiles, fine wire, etc. This type is equally effective for conducting or non-conducting materials, whether hard or soft, while those models in which contact pressure is completely absent are usable only on conducting materials.

The electronic unit, housed in a separate cabinet, uses three standard radio tubes. The control panel incorporates a switch and neon indicator lamp for the power supply and a green bullseye lamp as contact indicator. Another contact lamp is mounted in the base of the micrometer unit for convenience during adjustment of the screw.

The function of the electronic trigger circuit, shown in Fig. 3, can be explained as follows:

Anode and screen currents of both tubes flow through the potentiometer, R_k, in the common cathode circuit. The slider of R_k is adjusted at the factory to place a negative potential on the micrometer head by connecting a microammeter between the head and anvil terminals. The desired zero current flow, as indicated on a three microampere full-scale meter, usually will be obtained when the slider-to-cathode potential is at about fifteen volts. With the micrometer head and anvil separated, V_1 is biased only by its own grid contact potential, E_1, amounting to one or two volts. When contact is established, the potential, E_2, between the slider of R_k and the common cathode circuit will increase this bias, reducing current through V_1 almost to zero. In the absence of any other potential source, E_2 would create a current flow of about three microamperes between the head and anvil. The grid contact potential, E_1, however, is of proper polarity and magnitude to exactly counteract such a current. The source impedance of this contact potential is too high to contribute any appreciable bias, since the grid-cathode resistance is reduced from five megohms to about 500 ohms as soon as contact is made between the head and anvil.

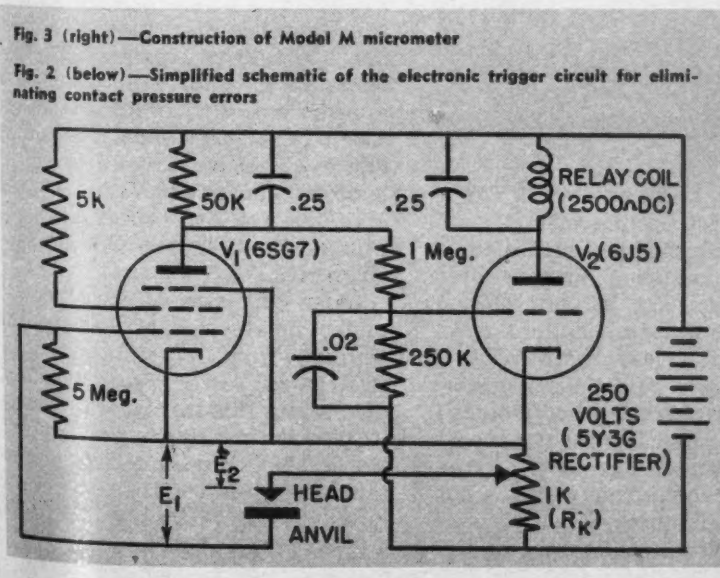
As the anode potential of V_1 rises, in response to increased grid bias, the grid of V_2 goes positive, causing a sufficient increase in current through the relay coil to close the indicator lamp relay.

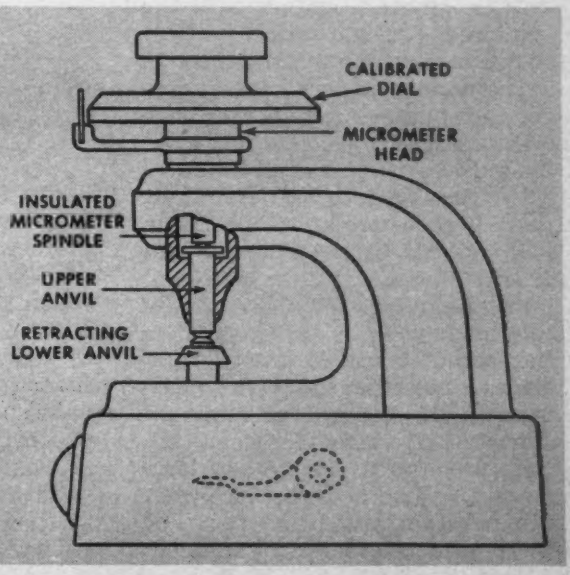
Electrical contact is established through the work piece itself, when measuring metallic or semi-conducting materials. For non-conductors, electrical contact is established within the gage head when mechanical contact with the work closes the small gap between two elements in the gage head.

An interesting observation made possible by the zero current electronic micrometer was that triggering was brought about before actual mechanical contact. This was studied by placing an electronic micrometer at one end of a 15 in. beam, supported on blocks, which were then subjected to distortion by means of temperature control. By this means, it was possible to study minute deflections, with the result that the phenomenon of space contact was discovered. Examination of a metal specimen coated with machinist's blue (of an almost molecular thickness) under repeated tests established that electrical contact was made, even though microscopic examination showed no break in the fragile

Fig. 3 (right)—Construction of Model M micrometer

Fig. 2 (below)—Simplified schematic of the electronic trigger circuit for eliminating contact pressure errors





film. Attempts to explain this observation led to three possible theories:

(1) that distortion due to gravitational effects on metallic masses had occurred;

(2) that some electrical capacity that might be associated with physical spacings of a few micro-inches was responsible;

(3) that the molecular boundary of matter might be less sharply defined than previously realized.

Dimensions of this order are, of course, not significant in any present gage block standards. Nevertheless, the ability of manufacturers to produce interchangeable parts of increased precision has, for some time past, exceeded the accuracy of instruments available for measurement of these parts. Major improvements in gaging, such as this electronic micrometer, may therefore open the way for new standards of precision in mass production.

"Visi-limit" micrometer

The use of a micrometer or dial indicator type of gage in the measurement of critical or soft materials always presents two problems. One relates to deformation of, or damage to the part during measurement, with resulting inaccuracy; the other involves the fact that continuous measurement of moving material introduces human errors which are often as great as 100% of the desired dimensional tolerance limitation. The Wilmotte[2] electronic micrometer has been designed to eliminate these difficulties. Since this instrument operates on a photocell principle, using light as a measuring medium, it possesses the singular advantage of providing accurate measurement without physical contact with the measured part, and thus is particularly suited to the measurement of razor blades, extruded plastic, rubber or plastic-covered wire and other critical or delicate materials. Since there is no physical contact with the part being measured, there is no deformation and therefore no inaccuracy due to this cause.

An example of the application of this micrometer is to be found in the manufacture of safety razor blades. Present methods of measurement of the edge-to-edge dimensions of these blades are incompatible with the high volume production methods because they demand that the production line be stopped in order that an accurate dimensional check be made, and further, that the particular blades so inspected be removed from production and either discarded or reprocessed at additional manufacturing expense. Such spot checks are completely inadequate and are responsible for large shrinkages in material and resulting economic losses.

Other applications of the Model P56 micrometer are to be found in the measurement of coated or bare filament; commercial wire; rod, bar, tube or strip stock of various materials; and paper covered wire. Measurement takes place during the manufacturing process on a continuous basis, while the wire or stock is passing through the machine on which it is being manufactured. Therefore, no limitations are imposed upon the speed of operation.

With suitable modification, the equipment can be applied to production gaging of the thickness of sheet stock of any material at as many points as desired across the width of the sheet. Measurements of this type cannot be made by conventional means.

The Wilmotte "Visi-Limit" micrometer contains three component

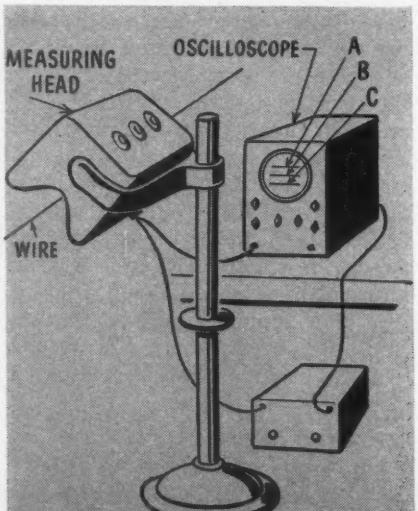


Fig. 4—Wilmotte photo-electric thickness gage

parts: 1. Measuring head; 2. Power supply unit; 3. Oscilloscope.

The measuring head, Fig. 4, contains the measuring aperture over which the material to be measured is fed. This aperture is illuminated by a projection lamp which casts a shadow of the object being measured on the cathode of a photocell which is located behind the measuring aperture. The area on the surface of the cathode which is not in shadow produces a voltage signal across the load resistor of the photocell. Two other apertures are placed alongside the measuring aperture and these are separately adjustable to represent the positive and negative tolerance limits to which the material must conform.

A scanning disc (Fig. 5) rotates between the apertures and the photocell, exposing each of the three apertures in sequence. As a result of this rotation, three voltage pedestals are fed to the amplifier circuit, each following the other in a time sequence which is synchronized with the disc rotation. At the points in the cycle where the scanning disc changes from one aperture to another, particular care in design is taken so that the total area uncovered at any one time is constant. Several important features result from this fact:

(1) The photocell emits a voltage signal which is ac in character and allows the use of ac amplification.

(2) The signal level changes only in proportion to the tolerance of the material under measurement and does not change with respect to the absolute dimension of the material.

(3) Sensitivity of the instrument is not dependent on the size of material being measured. For example: it is possible to measure a dimension of 0.6 in. or .005 in. within the same accuracy of ± .0002 in.

Each of the three voltage pedestals produced by the photocell is amplified in a common amplifier circuit and is then applied to the vertical deflection plates of an oscilloscope. The sweep voltage is applied to the horizontal plates of the oscilloscope in such a manner that termination of each viewing cycle occurs at the same time that the scanning disc alternates from one aperture to another. Each of these three voltage pedestals now appears as a horizontal line on the face of the oscilloscope screen, and, due to the persistence of the oscilloscope, combined with a rapid scanning rate, the three lines appear as simultaneous and continuous traces.

When the size of the material under measurement changes, the voltage signal represented by the test trace varies proportionately, and causes this test trace to change its position relative to the two limit traces. The two limit traces maintain their relative positions exactly as they have been adjusted for a given production run.

Simplicity of operation is a basic feature of this equipment. The operator of the production machine on which the micrometer is installed has before him a continuous visual representation of the dimensional quality of the product with respect to the tolerance limits set up for manufacture. When variations in the dimension of the product are noted, the operator can compensate for this quickly by making proper adjustments to the production equipment.

The stability of this equipment is due to the following factors:

(1) Voltage variations which would normally create fluctuations of the scope pattern cause no error, as all three traces move together.

(2) Gain variations in the scope or amplifier circuits cancel out, as all three signals are amplified in the same channel.

(3) The use of a single photocell eliminates error due to fatigue, temperature change and other variations which are commonly attributed to the photocell as limiting factors in its use as a quantitative measuring means.

(4) Vibrations of the material being measured do not cause an error in the measurement. The apertures are such that vibration in the horizontal plane merely changes the position of the shadow on the photocell and does not change its magnitude. The effect of vibration in the vertical plane is minimized by the use of parallel light, which avoids a change in position of the material being measured.

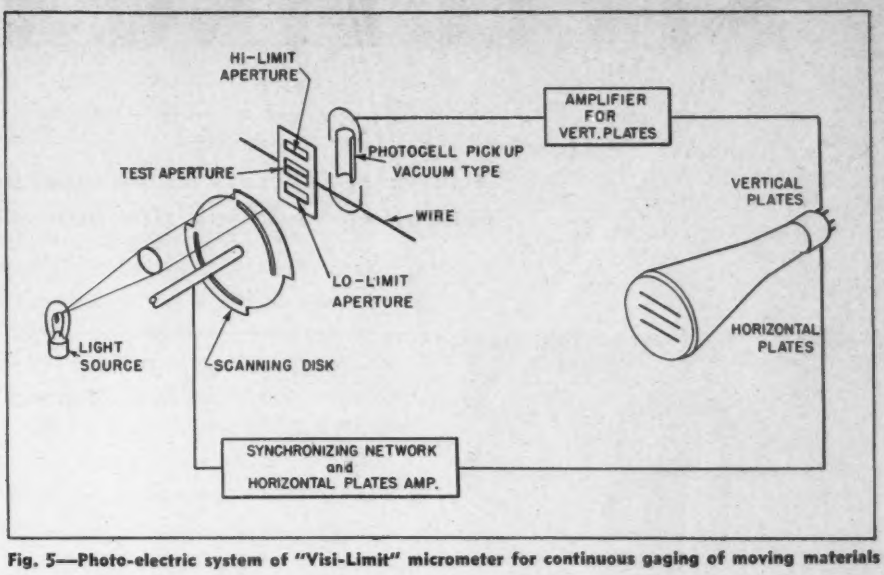


Fig. 5—Photo-electric system of "Visi-Limit" micrometer for continuous gaging of moving materials

It is possible to mount the equipment within four inches of a given extrusion head, or other support, thus avoiding the necessity of using rollers or other supports on the measuring head. A positive air pressure is maintained within the measuring head to prevent accumulation of dust in the apertures. The initial setup of the micrometer for a production run consists simply of adjusting the calibrated test aperture with the aid of a reference standard of known dimension, and adjusting the limit apertures with reference to a given change in the test aperture.

The measuring range of the type P56 micrometer is 0.005 to 0.6 in., while the type P56-1 covers 0.6 to 1.0 in. For both types, a dimensional change of ±0.0002 in. is readily detectable as a change in position of the oscilloscope trace. Accuracy performance is not affected by ±10% variations of 110 volt, 60 cycle supply lines.

Primarily designed for continuous production measurement of the outside diameter of insulated wire, this instrument has found wide application in the measurement of many other products whose standards of quality and economy of manufacture demand careful observation of dimensional tolerances.

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[1]Patents Nos. 2,290,940, 2,294,831, 2,302,-104. Robert W. Carson, Instrument Specialties Co., Little Falls, N. J.

[2]Raymond M. Wilmotte, Inc., 236 West 55th St., New York 19, N. Y.

NEW TERMS FOR THE RADIO ELECTRONIC VOCABULARY

• Military electronics during World War II developed a picturesque language of its own, confusing to the engineer and generally incomprehensible to laymen. Some of the following nicknames and terms may survive as part of our postwar vocabulary. They are listed here mainly out of respect for the part these devices played in the Allied victory.

AZON — Gravity-powered bomb, steerable in azimuth by radio control.

BAT—Self-guided missile with target-seeking radar control.

BLOCK—Lightweight airborne television system for Naval reconnaissance.

CARPET—An electronic jamming set used against the Germans.

CHAFF—See "Window."

DECCA—British navigational system using continuous waves.

FELIX—Bomb attracted to target by heat.

FISHHOOK—A countermeasure antenna for producing circularly polarized waves.

FLUTE—A smaller edition of the "Tuba".

GARGOYLE — Radar controlled glide bomb with jet engines and target seeking device.

GLOMB—Naval type glider bomb with television control.

GORGON—Stub wing rocket controlled by radio and carrying target seeking device.

GRASS—The noise pips on a high sensitivity radar receiver scope.

LORAN—Navigational system using pulsed transmissions.

PICCOLO — A smaller edition of "Flute".

RADAR—Radio detection and ranging using pulsed emissions reflected back from target.

RADIOSONDE — Balloon equipped with unattended radio for transmitting meteorological data.

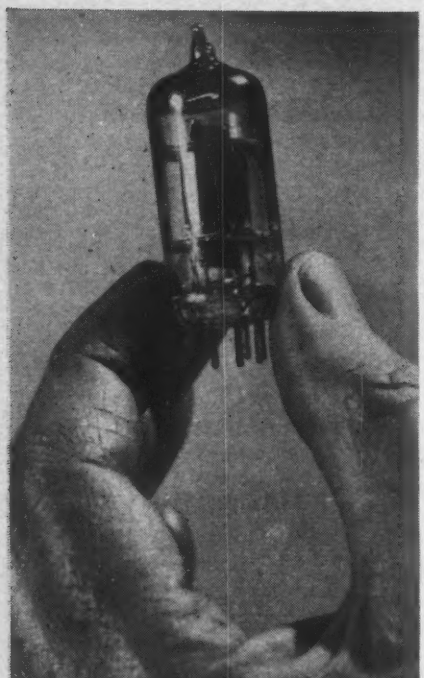
RAZON—Similar to Azon but controllable by radio in both azimuth and range.

RING—Similar to Block, but having greater range.

(*Continued on page* 130)

SELECTING PROPER

A survey of factors which must be considered in order to design reliability and long life into industrial electronic equipment



A trend toward using tubes of the miniature type is growing. This one is a thyratron with unipotential cathode

Prepared by engineers of the Advanced Development Laboratories, Sylvania Electric Products Co., Kew Gardens, N. Y.

● Because, up to the start of the recent war, electron tubes were generally used only for communication purposes, the literature was devoted mostly to circuit problems at audio and radio frequencies. While many of such circuits may be applicable to certain control and measurement uses where similar considerations occur, there are many places where normal communication considerations do not apply. Military developments have called attention to many of these—radar applications, various aircraft controls, and gun control circuits, which indicate principles easily incorporated in industrial instrumentation.

With low power considerations in mind, there are generally available many regular tube types designed for ordinary receiver and similar communication applications, plus a few special types, such as photo cells, gas triodes, etc. Much has been done during the war in increasing the reliability of these tubes and disseminating more information in regard to proper tube and associated circuit design considerations.*

For the present, certain characteristics common to receiver types must be observed in designing for control or measurement purposes. It should be recognized that measurement circuits (vacuum tube voltmeters, telemeters, frequency meters, temperature and pressure gages, etc.) may be required to provide high accuracy so that the variables involved in the tubes and other components must be minimized in design.

Magnifying variables

On the other hand for industrial controls of the simple on-off type, as used in certain photocell applications, safety devices and the like, the variable under control is of large enough magnitude that such accuracies are incidental. In more elaborate systems of control the same order of accuracy required in measurements is involved. Here the tube circuits magnify the small changes of some variable which takes place in a circuit where the power is too small to perform the control work directly. In many cases this variable will be non-electrical and the usual primary element available to convert it to voltage or current changes is such that amplification is usually required.

It is the intention of this article to call attention to some of the typical factors to be taken into account in proper design involving electron tubes. Some of these while well known to radio circuit designers, are not listed among characteristics in tube manuals. The most important are:

1. Contact potential.
2. Grid emission and gas.
3. Microphonics.
4. Ruggedness and other physical requirements.
5. Uniformity of characteristics between tubes and with life.
6. Tube and circuit noise.
7. Insulation resistance.
8. Special uses.

Contact potential

Contact potential is an important consideration with tubes used under "zero bias" or very low bias operating conditions. This is generally the case for high gain amplification tubes.

This term contact potential commonly refers to the potential that is required at the grid to just reverse the grid current. The value depends somewhat on the potentials applied to the other electrodes. It is the result of several factors, mainly the work function differential of the grid and of the cathode, and the initial electron velocity, with lesser contributions from gas current, primary grid emission, and the Peltier effect.

During life the work function of the grid surface approaches the work function of the cathode surface because some of the emitting material on the cathode is deposited on the grid and both elements then have nearly the same surfaces. The initial electron velocity decreases if the emitting ability of the cathode decreases with age. Since both of the first two factors generally decrease in magnitude the contact potential decreases in a normal tube with aging. These effects cause the grid to become more negative, whereas gas current and grid emission cause the grid to become positive. During life the tendency is for grid emission to increase whereas any gas occluded in the parts of the tubes generally clears up during life provided the tube is not overloaded.

Many tubes show a contact potential of about 0.8 volts when new and about 0.5 volts after one thousand

*Such as the JAN-1A Electron Tube specifications used by the services.

TUBES AND CIRCUITS

The requirements for industrial control and measurement purposes can be quite different from those used for radio communication or in equipment operated under the pressure of wartime conditions. Industrial tubes must have much longer life and be more stable in characteristics during life, than required for radio receiver types. They may have to perform under more adverse conditions of temperature, voltage sources and mechanical installation. The tube industry is according more recognition to these problems and the future may witness many more tubes designed especially for industrial purposes.

Circuit designers usually consider many operating characteristics not listed in tube manuals. The most important of these are listed and described here from the viewpoint that a good circuit designer will not forget to consider them. A circuit may work without giving any consideration to these points, but in certain cases some customers using the equipment may have difficulties in duplicating original performance as time goes on so it is well to keep all these matters in mind.—Editors.

hours of life. Battery type tubes run at a somewhat lower contact potential mainly because of the additional factor involving the filament drop along the non-unipotential emitting surface. In the normal cathode type tube the measured contact potential may vary from one and one-half to one-half volts depending on operation of the individual tube.

If a high resistance (1 to 10 megohms) is placed from grid to ground and no other form of bias, fixed or cathode resistor type, is used, a voltage approximately equal to the contact potential will appear across the resistor and act as bias. This is called "zero bias" operation. Typical examples of these types of operation are shown herewith. The grid current with no signal on the cathode type tube is limited to ⅛ microamp.

As the contact potential of the tube changes, the operating bias likewise will change. Generally for very low signal inputs this will not have too great an effect, but compensation by feedback or other means may be necessary if greater stability during life is required. To keep within reasonable amplifier linearity a shift of contact potential to a lower value will limit the maximum signal that may be applied. This is not only true of "zero bias" operated tubes but also the same order of maximum signal is permitted cathode biased high gain tubes for linear operation. If the signal is too great in this case the grid voltage will swing past the contact potential value on positive peaks and tend to draw enough grid current to cause nonlinear operation.

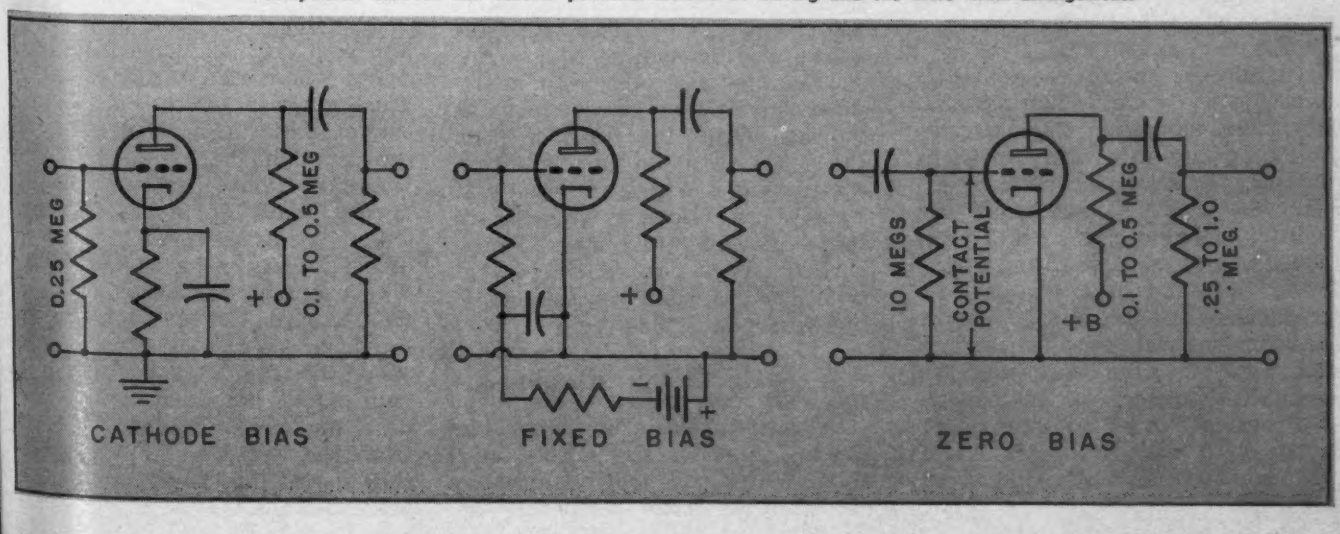
When lower grid resistor values are used the effect of contact potential variations on the operating bias (of "zero bias" amplifiers) becomes less. Besides limiting the permissible signal levels the decreased input resistance may adversely effect the signal from the preceding amplifier stage or signal source.

Grid emission and gas effects

Grid emission, mentioned previously, becomes an important factor when tubes with high heater power and plate dissipation (especially cathode types) are involved. In these types the grid sometimes runs quite hot due to its proximity to the cathode. Although its surface is sometimes prepared to inhibit such emission, emitting material from the cathode is eventually deposited on the grid allowing it to become an emitter.

The emitted electrons from the grid (which in amplifier circuits runs at some potential negative to that of the cathode) move to the cathode and return through the grid resistor so as to develop a potential making the grid less negative (relative to the cathode) than otherwise. The resultant increase in plate (and screen) current will increase the temperature of the tube and cause more grid emission resulting in a further increase in grid potential toward the positive grid region, and so on, so that the tube may eventually be destroyed.

Comparison between the contact potential method of biasing and the more usual arrangements



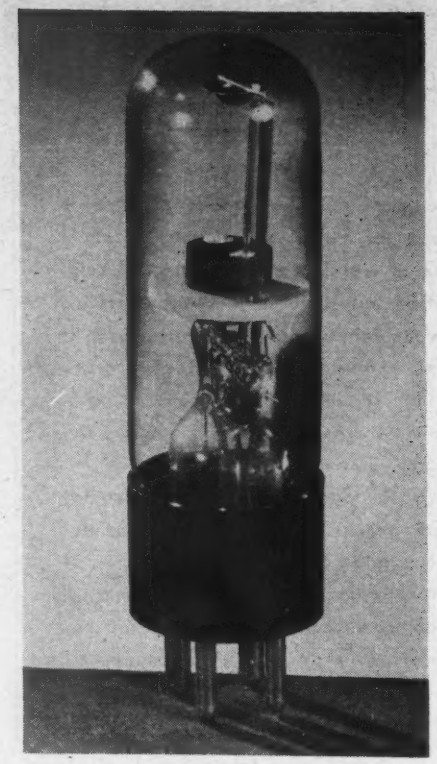
The effect of gas in the grid-cathode space is quite similar, in that electron emission from the cathode, knocking off electrons from the gas molecules converts them into positive ions which move to the grid which is most negative. The resultant removal of electrons from the grid causes grid current to flow through the grid resistor, and makes the grid potential less negative than otherwise.

It is, therefore, important not to use a higher value of grid resistance than specified by the manufacturers if the tube is being operated anywhere near its maximum rated conditions of plate and screen dissipation or temperature. For example, the specified grid resistance for the type 6L6G power output tube is 0.1 megohm if the tube is used with a fixed bias and 0.25 megohms if the tube is used with a cathode bias resistor. In the latter case any increase in plate or screen current will tend to increase the bias due to the cathode resistor drop and tend to counteract the effect of the positive bias increase in the grid resistor. Specially processed tubes would be required to perform satisfactorily with much higher grid resistors than those recommended.

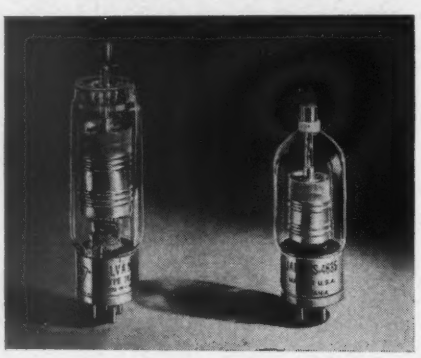
Microphonics

Microphonics or microphonic noise in tubes is caused by relative mechanical motion of critical parts initiated by acoustic feedback or by mechanical shock or vibration of the unit. If all mechanical motion could be prevented within a tube microphonics would no longer exist. To take care of thermal expansion some type of sliding joint must be provided in the direction of the core material with the greatest cross section to prevent the core material from warping during the operating cycle. This joint is usually as good as cost and ease of assembly will permit but this point may be a source of microphonics.

In the filament (directly heated) type of tube a string-like material must be supported close to surrounding elements with provisions for compensating for thermal expansion of the points along the emitter. Therefore, this emitter will act similarly to a vibrating string when subjected to mechanical vibration. With proper selection of emitter material and its supports and applying suitable tension the resonant frequency of this assembly can be moved into the upper audio band and out of the range of operation for many industrial uses.



A light source for a stroboscope, the SN4 is an internally triggered, cold cathode, gas filled thyratron giving maximum illumination



Larger hydrogen filled thyratrons, 5C22 and 4C35 featuring low deionizing time and high peak currents for control or pulsing use

Indirectly heated tubes (cathode types) may be found to have frequency microphonic noise, due to movement of the emitter within the supporting member.

Other predominant types of microphonics start from heavier elements moving within the tube, or from the entire assembly moving within the container. These are usually at a very low frequency and in all tubes are minimized by well supported construction. Further relief is obtained by vibration isolators or shockproof mounting.

Ruggedness

In referring to ruggedness, we usually think of the misuse and abuse that a tube will stand without showing either temporary or permanent deterioration. If all the elements within a tube could be designed with the same inertia and materials, then as shocks are applied, all parts would distort with uniform displacement, and this distortion would not cause any temporary or permanent deterioration. Naturally this is impossible, so it is necessary to select materials and supports for materials so that with normal use and abuse, parts will not be distorted.

The greater the reduction in mass, the less difficulty will be encountered. This in turn is likely to result in tubes of small size. Any tube design that features ruggedness and small size must necessarily be a series of compromises with respect to load handling characteristics and ease of manufacture. This means that tubes in general should be designed and built for the particular application in mind, and it is not wise to use tubes designed for one purpose for radically different usages. Since this places the industrial circuit designer at a disadvantage as most tubes that are readily available have been developed for radio communication applications, he must prove out his design by adequate tests, supplemented if necessary with information from the tube manufacturers as to lesser-known effects which may be encountered.

Characteristics

When the actual characteristics of a large number of tubes of a given type are examined it will be found that a relatively large difference exists between individual tubes. If a distribution curve is plotted of any particular characteristic, such as mutual conductance, determined at a given set of test conditions, generally it will be found that the familiar probability curve is the result. Although the testing limits at tube manufacturing plants are established to reject tubes whose characteristics fall at the extremes of the distribution curve, some idea of the spread which might be expected can be obtained from inspection of the testing limits on several common tube types as set down in the JAN-1A specifications for vacuum tubes. Two examples are shown opposite. One, the type 7A4 tube, is a medium mu general purpose triode while the other, the type 7B4, is a typical high gain audio amplifier triode. The data on these tubes as obtained from the JAN-1A specifications is shown with the "bogey" value. The minimum and maximum values are

given in JAN-1A and the "bogey" value is that value which is usually published in the handbooks and general tube rating charts.

From the data on the type 7A4 tube it will be seen that three points on the characteristic curve (I_b vs E_b and E_c) of the tube are checked, the principle point being at $E_b = 250$ vdc and $E_c = 8$ vdc. The cut-off test with $E_b = 250$ vdc and $E_c = -24$ vdc is made because the tube may be used in applications where the cut-off voltage is critical.

This test will show the effect of uncontrolled plate current which might be the result of a distorted or damaged grid which would not be noticed at the normal check point. A third test condition $E_b = 90$, $E_c = 0$, determines the shape of the characteristic curves in the low plate voltage, zero bias region. These three operation check points are suitable for selecting tubes for normal radio circuits but in some industrial applications other test points may be warranted.

The plate current limits of the type 7B4 are much wider than those on the type 7A4 tube because this tube generally will be used with a high value of plate circuit resistor and a cathode bias resistor so that the differences in operating points of widely different tubes will be minimized and the stage gain will be fairly uniform between different tubes. Usually the most important limit on the type 7B4 tube is the amplification factor since the tube is often used as a high gain amplifier.

Changing characteristics

It should be noted that the characteristics of the tube are a function of the applied potentials, and with constant dc potentials on the other elements the plate current (and likewise G_m and R_p of the tube) will vary considerably with filament or heater voltage. This is especially true of tubes such as the 7F8, 6J6, 6AK5 and many others which are designed to have a high G_m factor, with closely spaced elements.

One of the factors that has to be considered in the design of equipment utilizing vacuum tubes is the change in their characteristics with age. There are some general trends here but they depend considerably on the processing and manufacturing technics. It has been observed on a considerable number of receiver tube types that there is an initial drop in the characteristics: G_m, power output, diode emission, or gain, of the tubes when placed on life test. This drop may be as high as 10 or 15%, but the value usually returns to within a few per cent of its starting value at the end of 100 hours, after which there is another falling off of the characteristic of the order of one per cent per 100 hours operation.

After about 300 or 400 hours operation tubes which have not slumped excessively usually level off and become quite stable. These observations indicate that for some industrial applications present types of receiving type vacuum tubes may require additional processing and aging before being placed in equipment.

It is possible in designing equipment to minimize the effects of tube variation. Negative feedback is one of the common schemes for reducing the effect. Amplifiers can be built with very high stage-gain, which is then reduced to the desired value by feeding a portion of the output back to the input in such a phase relation as to reduce the output. This method will make the amplifier more nearly independent of variations of tube and supply voltages. Providing cathode resistance bias for a tube tends to correct for variations automatically from tube to tube and as the tube ages. In such applications as direct-coupled and direct-current amplifiers the use of balanced circuits of the bridge type with high values of common cathode resistors and other types of feedback again minimize many changes caused by the tubes.

	TYPE 7A4			TYPE 7B4		
	Min.	*Bogey*	*Max.*	*Min.*	*Bogey*	*Max.*
Heater Voltage ... (E_f) volts		6.3			6.3	
Plate Voltage .... (E_b) volts dc		250			250	
Grid Voltage ..... (E_c) volts dc		−8			−2	
Heater Current .... (I_f) ma	275	300	325	275	300	325
Grid Current ..... (I_{c1}) μa dc	0		−1.5	0		−0.6
Plate Current ..... (I_b) ma dc	5.5	9.0	12.5	0.4	0.9	1.7
" " ..... (I_b) μa dc $E_c = -24$	0		20			
Transconductance (G_m) micromhos	2075	2600	3125	1100	1500	2000
Transconductance (G_m) $E_b = 90$, $E_c = 0$	2400	3000	3600	....	....	....
Emission ..... (I_s) $E_b = E_c = 30$v, ma	40	..	..	40	....	....
Amplification .... (M_u)	18	20	23	85	100	115

Sources of noise

Random irregular currents introduced into a signal circuit by the amplifier tubes themselves, or any other electrical components, are a source of "noise" so called because it appears as such in communication circuits. The sources of noise present in an amplifier tube circuit are:

(a) Thermal agitation of electricity, which is the fundamental source. This is due to the free charge of any conductor being in random motion and in equilibrium with the thermal motion of the molecules, causing a random voltage to be developed across the terminals of the conductor. The RMS value of this voltage in microvolts is $E = 7.4 \times 10^{-6} \sqrt{TR}\ (\Delta f)$ where T is temperature in K, R in ohms resistance of the conductor, and Δf the bandwidth of the amplifier following the conductor of resistor.

For example, if the effective grid circuit resistance of the first stage of an audio amplifier is 2 megohms and the amplifier passes all frequencies from 50 to 10,000 cycles/sec., then at 20 degrees Centigrade, the effective noise fed to the first tube grid would be about 25 microvolts. Carbon resistors give values higher than this, due to minute arcing between particles, especially if the resistor has appreciable voltage drop.

(b) The noise introduced by shot effect of the electron stream (also by ions in the electron stream) which is not considered in the equation below, is due to the random rate of arrival of electrons at the plate causing a pulsating current to be superimposed on the average plate current. In pentodes, the division of current at the screen contributes additional noise.

The effective noise voltage at the grid of a tube due to these causes

$$\text{is } E = 16.8\ I_b\ (\Delta f)\ \frac{F}{G_m} \text{ microvolts,}$$

where I_b is plate current in milliamperes, (Δf) is bandwidth in cycles/sec., G_m is the mutual conductance in micromhos at the operating conditions, and F is the space charge factor.

Since most tubes operate according to space charge limited condi-

(*Continued on page* 130)

TELEMETERING FOR P

By DR. J. W. COLTON
Section Engineer, Research Labs, Westinghouse Electric Corp., East Pittsburgh, Pa.

Engineering details of the elaborate pressure measuring equipment used in recording the results of the Bikini atom bomb tests

• The cataclysmic explosions at Bikini Atoll last July were probably the most thoroughly examined individual phenomena in all of scientific history. Of prime interest to the Navy were the pressures developed by the blast and shock waves, for it is these that are responsible for the primary damage to vessels. In order to obtain quantitative information as to the magnitude and form of these waves it was necessary to have pressure measuring instruments within the area of extensive damage. To assure the securing of a record this information was transmitted by high frequency FM radio to a receiving ship located at a safe distance from the blast.

In the first test a total of 36 complete records of air pressure vs. time were recorded simultaneously from as many instruments located at strategic points on two target vessels. In the second test six records of water pressure vs. time similarly were obtained.

The development and assembly of pressure measuring and telemetering equipment was carried out under the direction of the Westinghouse Research Laboratories, and represents the joint efforts of Princeton University Labs, Cornell Aero Labs, NOTS, and Bureau of Ships. For the most part the equipment consisted of apparatus previously developed by these groups for various research projects during the war, though the severe conditions of the atomic bomb tests necessitated redesign of some portions of the equipment.

Water blast gear

The shock front which spreads out through the water from the explosion has such speed and is so sharply demarked that the pressure at a stationary point some distance from the source may rise from zero to thousands of pounds per square inch in a few hundred-thousandths of a second. The subsequent pressure fluctuations may be of important magnitude for as long as one second afterward.

The exceptionally large frequency range, which the telemetering equipment must handle in order to reproduce faithfully this wave, may be emphasized by considering the fact that if the rise of the wavefront occupied one-eighth inch along the record, the record would have to be 500 feet long to get a complete picture. Because of the high frequencies involved, a separate transmitting and receiving system was necessary for each pressure gage.

The pressure measuring device proper consisted of a piezo-electric tourmaline crystal, about ¼ in. in diameter, enclosed in a molded rubber case vulcanized to the end of a rubber - covered twin conductor shield cable. About one foot of this cable, with the gage on the end, projected through a packing gland from the hull of the ship below the waterline. Four of these were installed on one target ship, and two on another.

When pressure is applied to the crystal, a charge is developed and is proportional to the pressure. The cable is terminated in a relatively large capacitor, across which the charge develops a small voltage, and by the grid resistor of the first amplifying tube.

The time constant of this resistor-

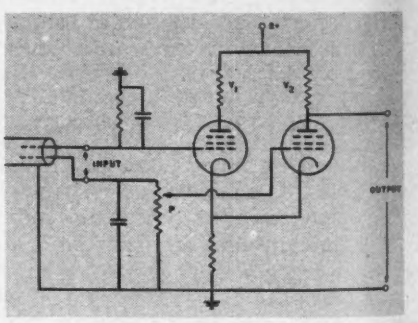
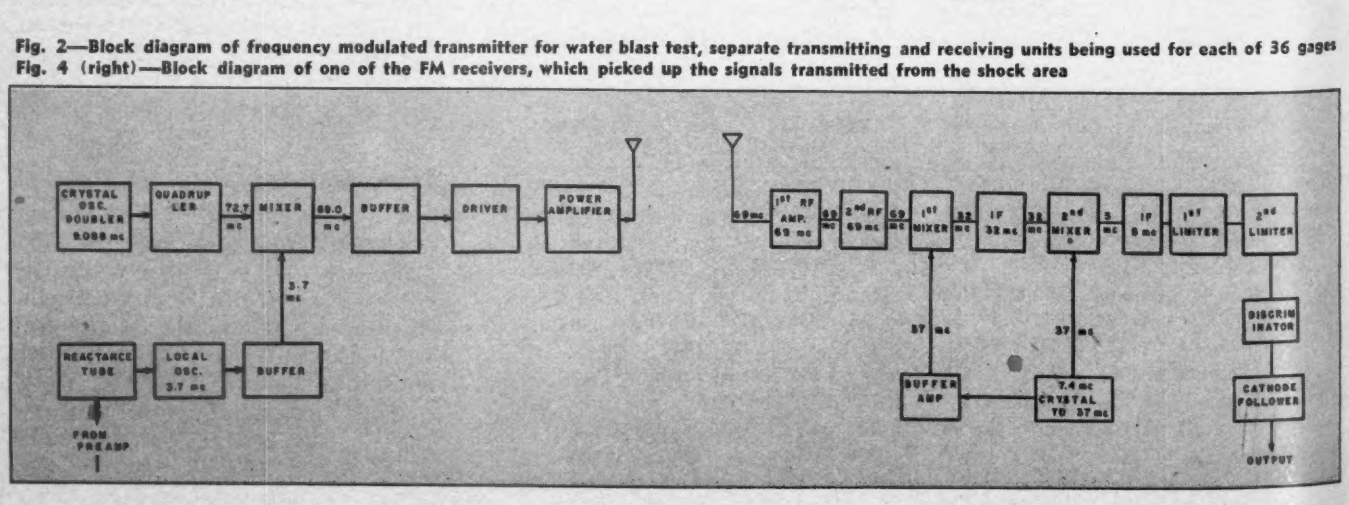


Fig. 1—Block diagram of preamplifier for water blast test

Fig. 2—Block diagram of frequency modulated transmitter for water blast test, separate transmitting and receiving units being used for each of 36 gages
Fig. 4 (right)—Block diagram of one of the FM receivers, which picked up the signals transmitted from the shock area



PROJECT CROSSROADS

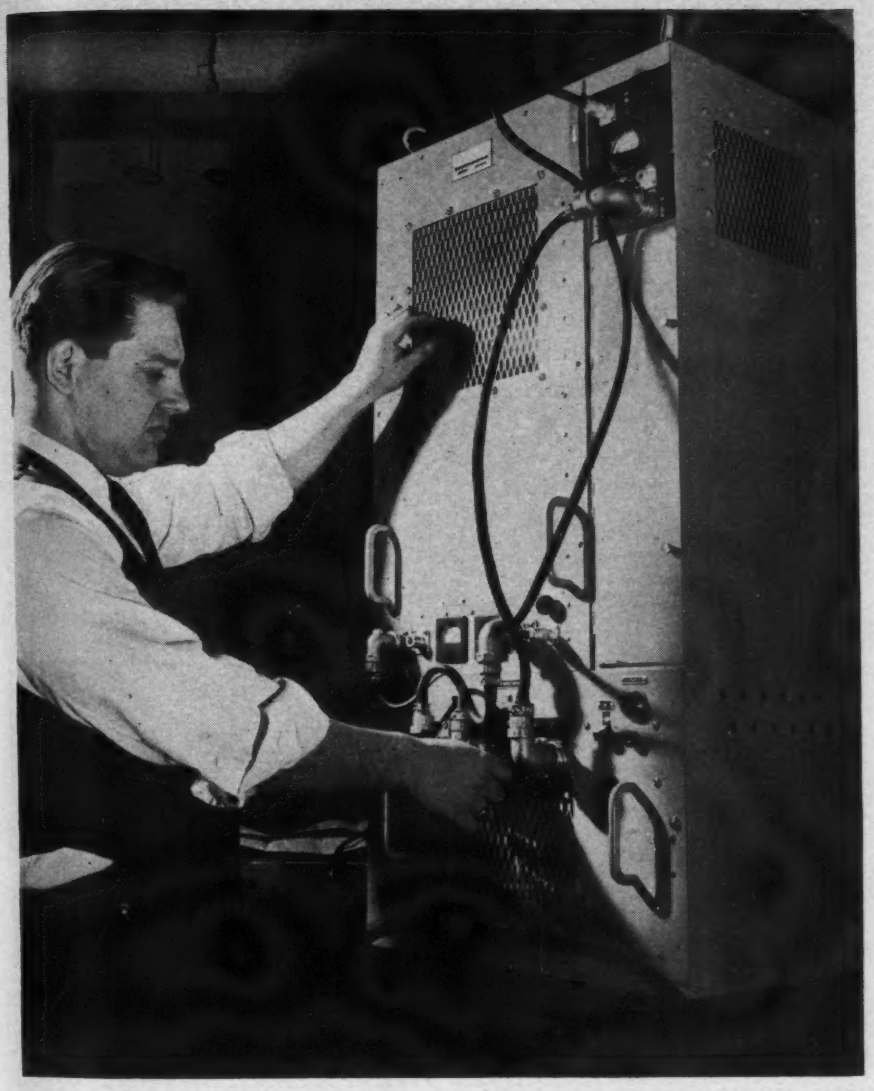


Fig. 3—This FM transmitter, located on the target ship, automatically sent signals of shock intensity to the mother ship, where they were received and recorded. The entire transmitting unit, complete with power supply, was housed in a single cabinet

capacitor combination must be sufficiently large to cause negligible phase shift at the lowest frequency (about 30 cycles). This required a high grid resistor (10 megohms), and to prevent changes due to humidity, the entire preamplifier is contained in a hermetically sealed case together with a drying agent. It has been found that the dielectric material of the cable also generates a charge under pressure. To eliminate this effect, a twisted-pair shielded cable is used, and fed into a special mixing circuit which is responsive only to voltages developed between the two conductors but not to voltage changes between the conductors and the shield. (Fig. 1)

The cathode follower V_1, is arranged to have a high following ratio, e.g. 0.9, and carries the cathode of V_2 with it. The potentiometer P on the input of V_2 is adjusted to the same fraction as the following ratio, and thus if the voltages on the input terminals with respect to ground vary together, the grid-cathode voltage of V_2 is not changed, and no output signal is obtained. Any differences in the input voltages, i.e. any signal developed between the input terminals, will appear on the plate of V_2.

The remainder of the preamplifier is of conventional resistance coupled design with a frequency response from 5 cycles to 50 kc. Well regulated plate supply voltages were a necessity. To avoid possible disturbances from the intense gamma radiation released by the atomic reaction from which the amplifier would be slow to recover, batteries were used. The preamplifiers were located at the respective gage positions, and their outputs fed through cables to the modulators at the transmitting stations. A block diagram of one of the six frequency modulated transmitters is shown in Fig. 2.

The crystal oscillator operates at 9.088 mc, and doubles in the plate circuit of the oscillator tube. A quadrupler furnishes the mixer stage with 72.704 mc, where it is combined with the local oscillator mid-frequency of 3.704 mc., the resultant 69.0 mc being the operating frequency of one of the channels. The frequency of the local oscillator can be varied ± 150 kc by means of the reactance tube modulator coupled to its tank circuit. The reactance of this tube is varied by the injection of the audio signal directly in its cathode circuit.

Thus the system has a frequency response which extends strictly to dc. The use of a crystal oscillator to furnish 95% of the final frequency and a high-deviation modulated oscillator for the other 5% results in good stability. The final power amplifier consists of a pair of Eimac 4-125A's in push-pull, with a folded quarter-wave line as a tank circuit. The output of the transmitter is 600 watts.

The entire transmitting unit, complete with power supply, is housed in a single cabinet. (Fig. 3). RG-18U cable was run from each transmitter to the vertical dipole antennas mounted as high as possible on the spars of the vessels.

At the receiving ship, only three antennas were used, each handling two adjacent channels which were separated by only .7 mc. These antennas were similar in design to the transmitting antennas, but were fitted with parasitic dipoles to provide directivity and thus extra gain.

The receivers were fixed tuned and had a crystal controlled local oscillator. To provide high sensitivity a double IF system, with the crystal oscillator serving both mixers, was used. Fig. 4 is a block diagram of one of the receivers.

The receivers required careful adjustment and strict adherence to the principles of good layout to prevent oscillation. A signal of 30 microvolts was sufficient to operate

both limiter stages. Since some loss in signal strength was expected due to the use of a single antenna to feed two receivers, and because of the critical nature of the coupling, separate preamplifiers were built for each receiver. These units consisted of a single amplifying stage operating at the channel frequency and were fed in pairs from each antenna by means of tee joints and cables cut to the proper length for optimum distribution.

The discriminator was of the conventional double diode type, and differed from the usual arrangement only by the fact that the output was directly coupled to the grid of a cathode follower. The output of the discriminator was linear over a frequency deviation range of 350 kc each side of center. The bandwidth of the receiver was 250 kc; this set the high frequency limit for the entire system. Though phase shift became apparent at frequencies of about 20 kc, a 10 kc square wave was accurately reproduced by the system, with a rise time of less than 5 microseconds and very slight rounding of the corners.

The recorder on which the final records were produced was capable of handling all six channels. Three double-beam oscilloscope tubes of 5 in. diameter and short persistence blue phosphor were mounted side by side at the bottom of a standard five foot rack cabinet. Two General Radio 651 AE cameras with f/1.5 coated lenses were mounted on top of the cabinet to photograph the faces of the oscilloscope tubes.

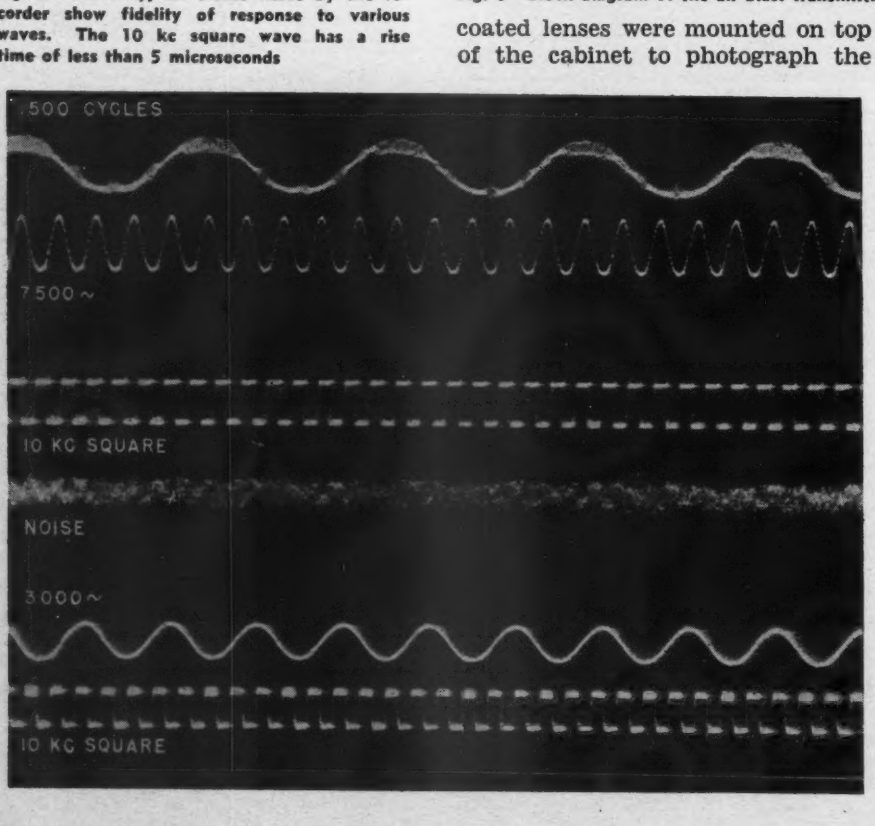


Fig. 5—These typical traces made by the recorder show fidelity of response to various waves. The 10 kc square wave has a rise time of less than 5 microseconds

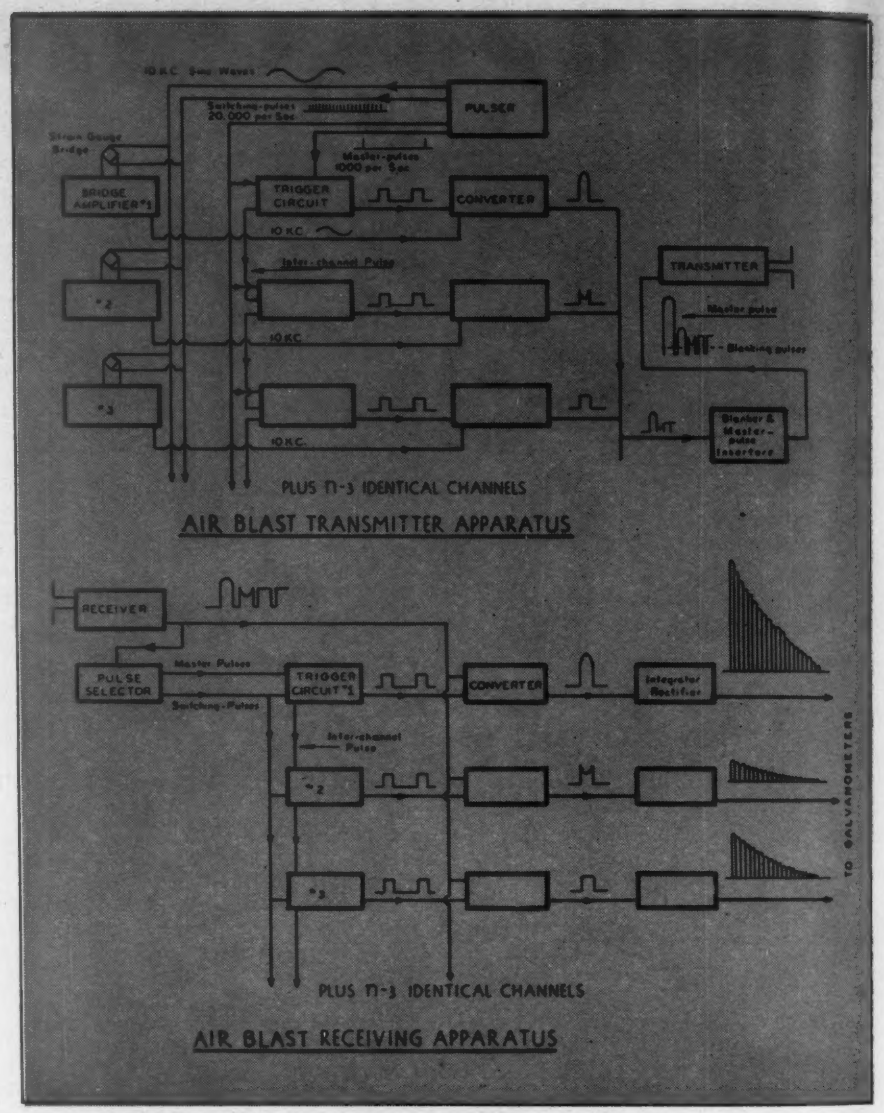


Fig. 6—Block diagram of the air blast transmitting and receiving apparatus

In the final analysis the film on which the records were made was the sole product of months of development, assembly, and installation of costly equipment, together with the expenditure of thousands of hours of scientific and engineering effort. To reduce the chances of failure at this critical point, and during the subsequent photographic processing, two records were taken simultaneously. Each camera photographed all six electron beams and the filament of a small lamp bulb, which provided a base line.

The film moved continuously through the camera at a speed of about 30 feet per second. This furnished the time base, and was marked at regular intervals by interrupting momentarily the oscilloscope beam. The beam deflection was of course at right angles to the film motion. One hundred foot rolls of recording panchromatic 35-mm film were used. Since the motor required a short time to accelerate the film to full speed, it was neces-

sary to start the cameras rolling a fraction of a second before the blast. This was done automatically by means of a delay mechanism actuated from the warning signal 2 seconds before the explosion.

The six video amplifiers for the oscilloscopes were two-stage direct-coupled balanced amplifiers using cathode degeneration to minimize drift and unbalance. For test purposes a sawtooth sweep could be applied to any or all of the six beams.

With this recorder a maximum writing speed of ¼ in. per microsecond at the oscilloscope face was attained. A sample test record is reproduced in Fig. 5.

Calibration of the complete telemetering system, from the terminals of the crystal gage to the deflection of the oscilloscope beams, was made possible by the provision of a relay at the input terminals. This introduced a known signal derived from a battery and having a value equal to the peak signal expected from the crystal.

A second recorder, similar in nature to the one described but using six three-inch oscilloscopes was developed independently by the group at Cornell. This recorder used 1000 ft. rolls of unperforated film, and was used simultaneously with the first to record disturbances of long duration.

Air blast equipment

The problem of measuring the air pressures developed by the explosion had several features which distinguished it from that of the water pressure. First, the frequency range involved was very much smaller, coverage up to 200 cps being considered adequate. Second, because of the great variations in air pressure expected at different points of the ship, it was desirable to have a relatively large number of measuring stations. Eighteen pressure gages were installed on each of two target ships. These were located on the outside of the hull, both toward and away from the blast, on masts and spars, and on various bulkheads both above and below decks. Each gage was set to give full scale reading at the pressure expected.

The actual sensitive element was a strain gage, a wire of special alloy which changes its electrical resistance when it is elongated. Four of these wires are connected in a bridge circuit, and mechanically mounted in such a way that upon movement of a link, two opposite arms of the bridge are elongated

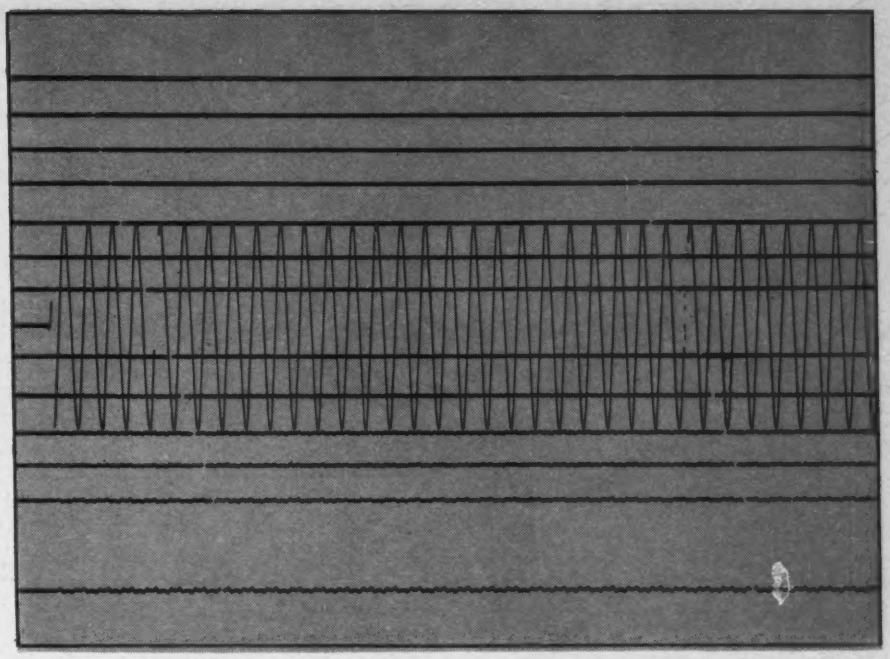


Fig. 7—These fourteen traces record air presssures at as many target locations. While all indications are simultaneous, the timing marks are staggered to aid in identification

while the other pair is shortened. Air pressure is translated into movement of this link by a metal bellows. The whole mechanical system is sufficiently stiff to give a response to pressure variations independent of frequency over the 200 cycle range.

Because of the relatively small frequency range necessary, it was possible in this test to use a multiplexing system which transmitted simultaneously eighteen sets of information on a single frequency modulated radio link. This was accomplished by means of a time-division system consisting essentially of two electronic "commutators", one at the transmitting location and one at the receiving station. These were run in synchronism, the transmitting commutator sampling signals from gages 1 to 18 in order and the receiving commutator distributing the signals in the same order to recorders 1 to 18 at the receiving station.

The whole cycle of commutation is repeated 1000 times a second, and with 20 channels (there are two blank sampling periods) each gage is examined for 1/20,000 of a second. The upper frequency limit which can be obtained from a single gage is thus determined by the frequency of commutation (1000 cycles) while the radio link must be capable of transmitting and receiving 20 times this frequency. Fig. 6 is a block diagram of the complete system.

The strain gage bridge is excited by a sine wave alternating current of 10 kc. The output of each bridge is thus a 10 kc wave varying in magnitude in accordance with the applied pressure. The output of each is fed through a tuned amplifier to a converter (or switch) tube whose cathode resistance is common to all the channel converter tubes. Each of these tubes is turned on in succession for 1/20,000 second, the resulting output being therefore a sampling of all channels. The switching is accomplished by a trigger circuit in each channel.

Each circuit is triggered on in turn by the pulse produced by the circuit of the previous channel when it switches off. After 1/20,000 of a second the circuit is switched off by pulses fed simultaneously to all channels from a synchronized pulse generator operating at 20,000 pulses per second. To maintain stable operation trigger channel #1 is not set off from channel #20, but is triggered by a master pulse from the pulse generator every 1/1000 second.

A blanker is inserted in the combined output which effectively cuts a slot in the signal between each channel. This is done to reduce the frequency response required of the radio link thus preventing adjacent channel cross-talk, and to provide synchronizing pulses for the receiving commutator. A master pulse is also inserted by this circuit just previous to the switching on of channel number one. This assures proper phasing of the transmitting and receiving commutators.

At the receiving station, the signal output of the receiver is first

(*Continued on page* 135)

VACUUM TUBES IN I

By RALPH R. BATCHER
Consulting Editor, Electronic Industries

In industrial fields, electronic devices, heretofore used largely to duplicate and sensitize other control systems now do many new jobs

• The large chart folded in with this issue illustrates some of the characteristics that account for an accelerated trend toward electronic instrumentation. Since early control systems were developed using either mechanical, electrical, pneumatic, or hydraulic transfer mediums, the tendency among industrial men is to compare the features of the newer electronic methods with those older arrangements.

On the other hand, although electronic circuit arrangements and expedients used in accomplishing the many unusual effects are common knowledge to engineers in the electronic field, equivalent methods of doing the same things by other systems have seldom been analyzed by them, and at present many are handicapped by a lack of knowledge as to specific instrumentation problems.

This is partly because of the wide discrepancy in terms and (in the opinion of many) the cruder symbols and methods of picturing system arrangements used in the books, catalogs, and publications in the industrial process control field.

Much of the information detailed on this review chart is self-explanatory. In general there are shown certain system counterparts and devices whose operation simulates that of some item in another system. In the tables of system quantities shown at the top, items in each horizontal line across the five tables are not identical but in each case they may represent analogous concepts which may make it easier for anyone well versed in any one system to understand quickly the relations in some other field.

Many electrical engineers like to size up operating relations in other fields by thinking — that's the "Ohms law" of the system. Therefore, under each heading, the quantities horizontally aligned with the potential, resistance and current quantities in the first section are related by an equivalent of Ohms law. Power, energy, and quantity of the medium "flowing" likewise are horizontally aligned.

In each group certain interrelations between the items are listed and others may be derived by analyzing the dimensional formulas. There may be differences of opinion as to what is a common unit in some cases since certain quantities are called by several names.

Diagonally across the sheet, in double circles, is pictured a random selection from a wide variety of components and principles used in electronic circuits, with an operational facsimile from another system alongside. These pairs are to be considered as accomplishing similar effects. Specifically, these show:

(1) The basic principle of all control, the introduction of a resistance or pressure drop in a system. This is effective only when a flow occurs, and usually the loss of pressure is proportional to the flow.

(2) A rapidly expanding field of activity for electronic devices is based on the application of ultrasonic vibrations to the material in a process for mixing, changing molecular sizes, drying, or producing numerous other effects. Measurement of viscosity, moisture content and other factors sometimes is possible by determining the attenuation of ultrasonic waves passing across the mix.

(3) A simple analog between capacity and inductance (momentum) is afforded by this simple filter comparison.

(4) The principle that a rotary pump will regulate flow in a system without regard to pressure or head is in correspondence with that of the constant current device—a pentode which passes a definite current over fairly wide limits, irrespective of the voltage applied to the circuit. This principle is frequently used.

(5) The basic amplifier characteristics found in a simple triode circuit correspond to the fundamental vane and jet arrangement of the pneumatic system. The output pressure or voltage can be varied over fairly wide limits to accomplish other control effects, but is always less than the system pressure or voltage. In the examples shown, a 2-10 lb. variation (or a 20-100 volt change) is obtainable from the system's 18 lb. (or 180 volt) basic potential.

(6) In this floating control system the pneumatic motor simulates a simple split field motor under the control of a balanced-tube field control arrangement. The unbalance voltage, here shown as resulting from the rheostat setting, can, of course, be obtained from other sources.

(7) In a common voltage stabilizer circuit, the potential drop across an electronic tube (triode) is controlled by the amplified version of voltage variations in the system. Any small voltage change in the output circuit immediately

COLOR CHART SUPPLEMENT

The Chart Supplement enclosed with this issue of Electronic Industries will help in making more easily understandable the many ways that vacuum tubes may be used either as substitutes for other equipment, or to supplement it. To make the picture plain, analogous functions between mechanical, hydraulic and pneumatic methods and their electronic counterparts are illustrated. These feature many electronic methods as currently used, or possible of adaptation for monitoring, control and measurement instrumentation in industrial operations

INSTRUMENTATION

affects the amplifier tube and creates a change in the impedance of the control tube to correct the change. A pressure regulator system using a control and pilot valve (or valve positioner) accomplishes a similar effect.

(8) A relaxation oscillator circuit containing a thyratron tube is a common item in electronic systems (oscillograph sweep circuits, etc.). The capacitor charges slowly through a resistor until a potential is reached where the thyratron breaks down and becomes conductive. The charge is thereupon dissipated and a new charging cycle starts. In the hydraulic analogy a tank fills slowly through a resistance or valve, until the float rises to a point where it trips off the dump valve. The tank then discharges rapidly until the flow ceases around the dump valve so that it can reseat. The cycle of operation in each case depends on the resistance in the charging lead, and the capacity of the tank or condenser up to the level where the discharge starts. The discharge is usually more rapid than the charge because of the lower resistance in the discharge circuit.

Positional control

(9) Shows two analogous systems of positional control — electronic and pneumatic—that are arranged to guide a mechanism around cams or irregularly shaped templates. In the electronic system* a phototube and light source are focused on a mark on a paper template. A powered traction wheel moves this assembly forward but in a direction controlled by worm gears that are driven forward or reversed as necessary so that the phototube "sees" the marking at all times. To do this, the worm shaft is controlled by a reversible motor operated by the amplified signal from the phototube. This arrangement pulls along a series of gas cutting torches.

In a pneumatic arrangement† a double acting cylinder is driven by air entering one of two adjacent orifices from an air jet moved by a sylphon bellows. The movement of the latter is controlled by the air pressure established by a jet-nozzle arrangement, between which the edge of the template moves. As the latter rotates, the position of the jet is changed by the action of the piston in the cylinder, until the same pressure is reestablished by the sylphon.

One of the main features of electronic control is the ease with which the characteristics of the system can be modified (12) to incorporate selected rates on proportionalities by rather simple changes in the amplifier system. An extremely long list of possible modifications could be compiled from existing apparatus diagrams.

Items (14) and (16) show several typical circuits giving amplification rates that follow non-linear curves. With the expansion amplifiers (14) the output can be adjusted to follow a square-law relation to compensate for non-linear effects in some other part of the process, or to apply proportionally-greater corrective influences when the system shows wide departures from normal.

Process variables

These circuits utilize the screen grid control characteristics of pentodes. Oscillation or regenerative feedback is avoided by adequate filtering of the output of the rectifier tube before reinjection into the screen grid control. Such circuits were originally designed for audio amplifiers. Since the process variable in many industrial systems changes at an extremely slow rate, this means that this rectifier and filter must give an extremely smooth output at low frequencies. Attention must be given to its phase shift characteristics as well, to prevent low frequency oscillatory feedback.

A modification of this same method will give logarithmic gain characteristics (16). There are many other ways by which the AVC circuits, so commonly applied to communication amplifiers, can be used in control amplifiers for industrial purposes. These can be made to operate below or above a selected threshold value (or dead zone) as desired.

Frequency is a quantity that can be measured with a precision that is many times greater than that of any other quantity. It is so closely linked with "time" that seven place accuracies can be obtained with relatively inexpensive setups. Unlike amplitude effects at the usual industrial control speeds, its value remains unchanged while it is being transferred over widely different connecting circuits. For this reason a control medium receiving much attention is that based on using a variable frequency signal as the transfer agent. This principle avoids many of the troubles found with amplitude control when large or variable distances must be covered. In (15) a few typical variable frequency generators are shown. The first uses a sylphon bellows or other displacement mechanism to alter the frequency of a stretched wire, the latter being the frequency controlling element of an oscillator. This Vibrotron unit is capable of extremely fine frenquency calibration.

Another simple oscillator of the multivibrator type delivers a frequency that is at all times dependent on the temperature of two NTC (negative temperature coefficient) resistors which are commercially available. Frequency changes of the order of several percent per degree (C) are obtainable.

Pressure effects

Two simple methods of altering the output frequency of a feedback oscillator by pressure effects, incorporate sylphon bellows to change the capacitance (by directly altering the spacing of the plates) or the inductance (by shifting the inductance of a flat spiral coil near its movable end plate) of the LC circuit of the oscillator. Typical forms of these converters are shown at the center of (15) on the chart.

Below this a method of generating a variable frequency signal in accordance with the light falling on a gas-filled phototube is shown. Such a tube is connected in a relaxation oscillator (similar to item (8) on the chart) in parallel with a capacitor. The latter is charged at a rate depending on the supply voltage and the impedance of the pentode. The discharge point, and hence the frequency, is thus dependent on the light falling on the phototube.

The advice of Professor C. A. Kayan, Columbia University, and Ed. S. Smith, Bendix Aviation Corp., and members of the editorial staff of ELECTRONIC INDUSTRIES regarding this chart is gratefully acknowledged.

*Described in ELECTRONIC INDUSTRIES, May, 1944, p. 127.
†Brief description by Ziebolz (Instruments, Vol. 15, Sept., 1942, p. 342).

ELECTRONIC TRUE

By H. GREGORY SHEA, Associate Editor, Electronic Industries

Numerous recent advances in the original Eccles Jordan flip-flop circuit open up the field of counter circuits for industrial usage

● Binary counters using a pair of triodes in a flip-flop or modified Eccles-Jordan circuit have been described quite fully in numerous articles. However, since these circuits count by powers of 2 some modifying scheme is always necessary to obtain decimal counts. Furthermore, simple connections of low wattage neon lights to the plates of the tubes in the flip-flop circuit for indicating purposes results in an indication that is difficult to read.

This can be seen from Fig. 1 which shows an ordinary binary circuit. One pulse in the input line will make the first double triode change from conduction through A to conduction through B, thereby lighting neon lamp 1. The second pulse turns off lamp 1 and lights lamp 2. The third turns on 1 again so that the numbers from one to ten must be obtained mentally by adding numbers corresponding to the lighting of certain of the neon lamps as shown in the following table.

Pulse Number	Neon Lamps Lighted
1	1
2	2
3	1 + 2
4	4
5	1 + 4
6	2 + 4
7	1 + 2 + 4
8	8
9	1 + 8

While this sort of an arrangement may work in a laboratory or with specially trained personnel it is not defensible for general industrial work.

What is wanted is a true decade arrangement which will show directly the number of the counts.

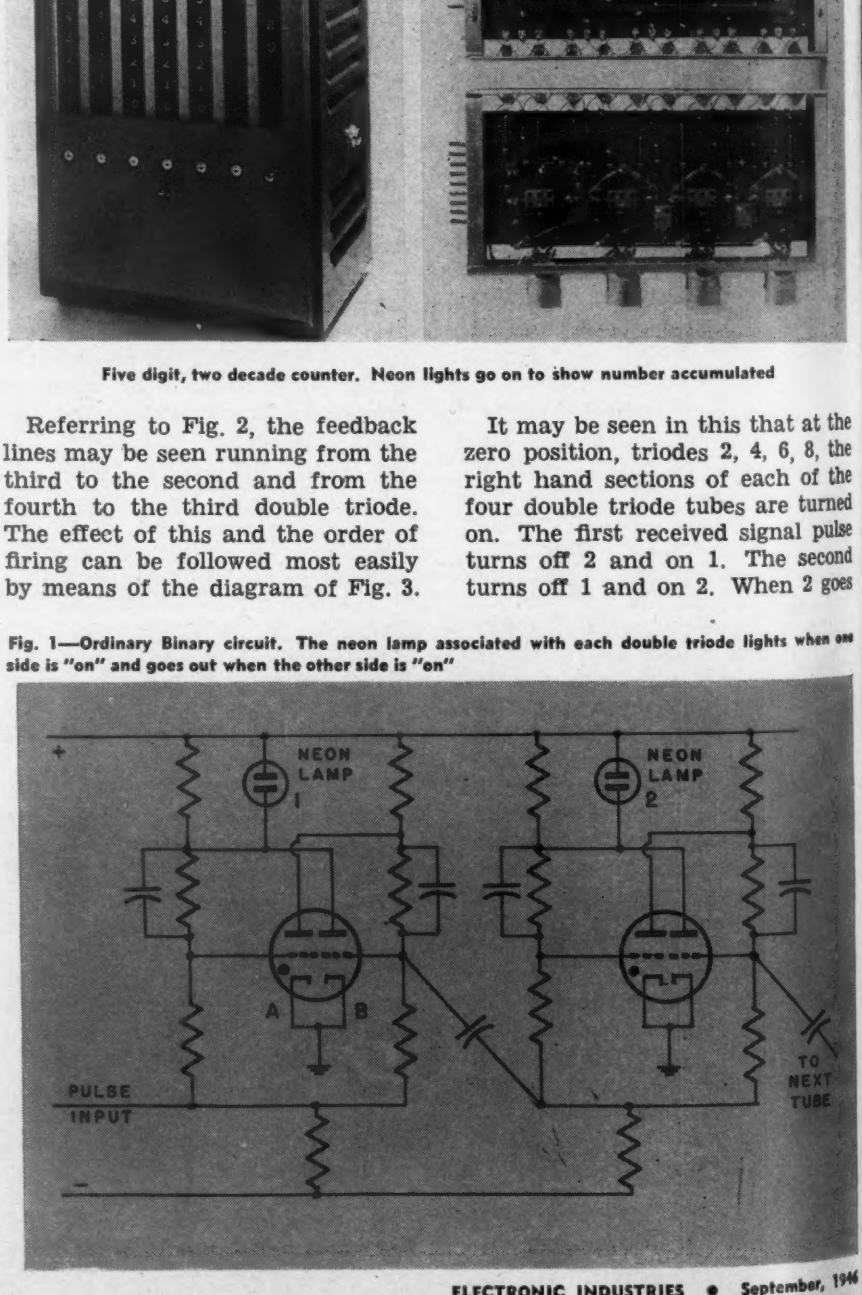
Several schemes have been proposed for obtaining this result. One of the simplest is due to I. E. Grosdoff of the Princeton Laboratories of the Radio Corp. of America. Two features are involved. First, a feedback scheme at two points in a four double tube binary counting decade, and second, the interconnection of indicating neon lights into two interacting groups.

Five digit, two decade counter. Neon lights go on to show number accumulated

Referring to Fig. 2, the feedback lines may be seen running from the third to the second and from the fourth to the third double triode. The effect of this and the order of firing can be followed most easily by means of the diagram of Fig. 3.

It may be seen in this that at the zero position, triodes 2, 4, 6, 8, the right hand sections of each of the four double triode tubes are turned on. The first received signal pulse turns off 2 and on 1. The second turns off 1 and on 2. When 2 goes

Fig. 1—Ordinary Binary circuit. The neon lamp associated with each double triode lights when one side is "on" and goes out when the other side is "on"



DECADE COUNTERS

on, its plate voltage drops and the consequent negative pulse turns off 4 and on 3.

The third pulse turns off 2 and on 1, while the fourth turns on 2 which turns on 4 which turns on 5 and off 6. When 5 goes on, however, it feeds back to 4 turning it off again and making 3 go on. The rest of the action can be seen at a glance for each succeeding pulse till the 10th which gives settings identical with the beginning state and by turning tube section 8 on initiates a pulse on the output line. This final pulse is applied to the next decade.

Indicating arrangement

Consider the method of connection of the lights shown at the top of the diagram of Fig. 2. All even numbered lights are connected to triode section No. 1 and all odd to No. 2. Thus a high positive plate voltage will be available at the top side of either the even or odd bank of lights for each pulse sent into the decade, since triodes 1 and 2 alternate in becoming conducting at each pulse.

The lower sides of the lamps are connected into pairs, each pair being tied to the plates of two triode sections by individual resistors. If the two triode sections are each in a conducting state with plate voltages low, the voltage difference across the neon lamp is enough to light it.

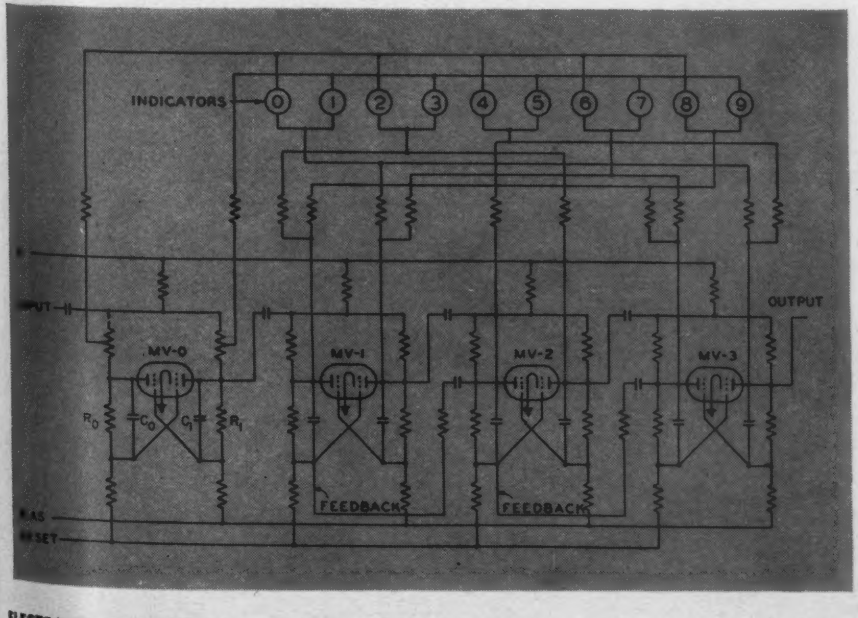
If, however, only one of the triodes is conducting, there is a voltage drop from the "off" triode through the coupling resistors to the "on" triode. The voltage at the neon lamp is not sufficient to light it under these conditions. This is shown in Fig. 4. At pulse "1", neon indicator 1 is lighted, having 100 v across it because triode sections 4 and 8 are both "on" and their plates are at +80 v. At pulse "2" however, triode section 4 goes out as may be seen in Fig. 3. This raises its plate to 150 v and the base of the 0-1 indicator pair to 115 v. This makes both lamps 1 and 2 go out, the 65 v across 0 being insufficient to light it.

Anyone who has ever set up a flip-flop circuit knows that certain difficulties are apt to arise in connection with it. Particularly, it should be noted that the shape and magnitude of the pulses intended to operate the circuit are important. Failure to pay attention to such questions will result in skipped counts and double or multiple counts.

When section 2 of the first double triode of Fig. 2 is conducting, its plate voltage is possibly 70 v lower than that of section 1. Resistance and capacitor R_1 C_1 have about 50 v less across them than R_0 C_0. A 10 or 15 v negative pulse will momentarily drive both ends of the capacitors down by this amount because it takes time for capacitors to alter their charge and voltage.

Hence the first result of the pulse arrival is that both tubes are out.

Fig. 2—True Decade Counter circuit using 4 double triodes and feed-back to the third and fifth triode sections. Neon lamps indicate the correct count directly



The pulse having ended, both grid and plate voltages begin to rise, but the bottom of C_1 reaches the "turn on" point for section 1 first because C_1 has less charge and voltage than C_0. If the pulse lingers, however, C_0 and C_1 voltage become equalized and there is uncertainty about which triode will go on first. A similar situation may exist if the pulse is too large. If it is too small

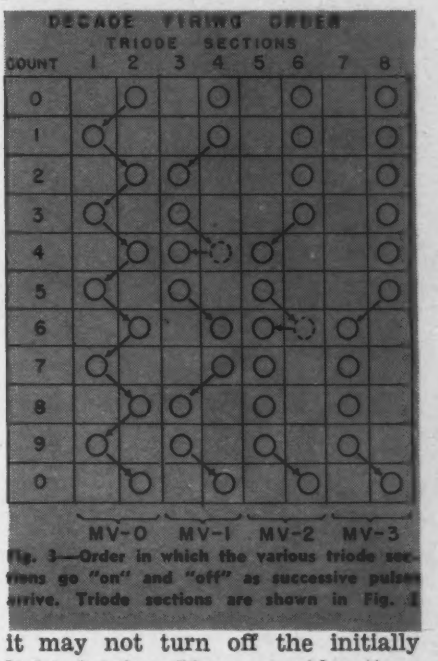


Fig. 3—Order in which the various triode sections go "on" and "off" as successive pulses arrive. Triode sections are shown in Fig. 1

it may not turn off the initially lighted tube. These considerations also govern the choice of capacitor and resistance values. In addition operating time must be considered.

Present counters have a maximum operating speed of possibly 1 to 1.6 mc. Such speeds require particularly careful consideration of component sizes as the capacitors must be very small to have a fast recovery time. Higher speeds have been facilitated by the use of 6J6 miniature tubes as they have low interelement capacities. Operated between +200 and —60 v. on the plate and bias lines, these tubes give very satisfactory results and take little space.

Industrial applications

Numerous processes in industry require the starting and stopping of mechanisms after a predetermined number of processes have occurred. There are several possible ways in which this may be done. Of course, the initiating impulses can be obtained by means of a photoelectric tube or a resistance, capacity or inductance change. But then, the

problem arises of how to stop the machine at an exact point as for instance after a certain exact number of links have been put in a slide fastener so it may match perfectly with its mating slide.

Since a counter consisting of several decades will normally deliver an output pulse when all decades are turning from the figure 999 . . . 9, the full capacity of the machine to 000 . . . 0, it is possible to set up in advance on the counter a number which is the reciprocal of the desired number. Then when the

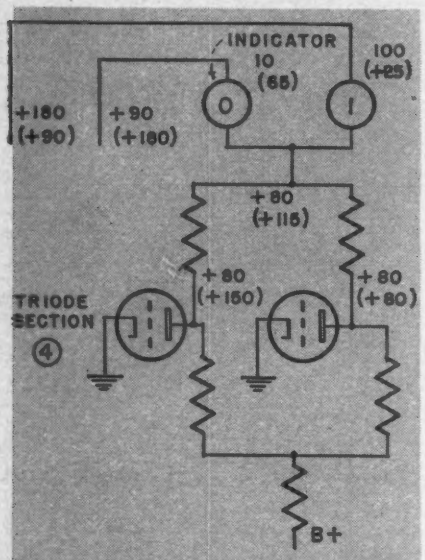


Fig. 4—Voltage variations across the neon indicator lamps which determine "on" and "off" conditions. The voltages in parenthesis are for one pulse later than those not in parenthesis

desired number has been counted off, the counter will reach full capacity.

Another scheme adapted to the circuit of Fig. 2 is shown in Fig. 4 where the indicator lights are shown in a block connected to a 9-point 2-section switch by means of which any pair can be selected. The number desired is set up on the switch for each decade. When this number is reached the decades trigger a group of low impedance tubes such as the 6A3 or 6A5G all connected in series giving a current pulse sufficient to operate the stopping switch.

Pentode circuits

Other counter circuits are available and one which has been described* recently makes use of directly coupled pentode trigger pairs as shown in Fig. 6. In this case the screens are used either to block or permit conduction. The scheme is economical in its use of components but requires twin pentodes or else twice as many single pentodes.

It can be combined in a ring of ten circuits using five twin pentodes so connected that there is always a continuous group of five "on" and five "off". The group "on" progresses around the circle for each count. The circuit is shown in Fig. 7. Action is obtained by means of positive rather than negative pulses.

When a positive pulse is applied to the grids of Fig. 6, the "on" tube is not affected, but the "off" tube is made conducting and suffers a sharp plate potential drop. This pulses the screen of the "on" tube sharply negative and with proper circuit constants, will cause it to cut off. Such action raises its plate potential and the screen potential of the tube originally "off" thus reinforcing the "on" lighting action.

In Fig. 7 any tube within a group of "on" tubes is kept "on" rather than "off" by the low plate potentials of its neighbor tubes acting through the plate coupling resistors. The tubes most easily triggered are the ones on the ends of a group of 5. The control grids, all connected to the central ring receive positive pulses of limited amplitude. These produce negative pulses at the plates of the "off" tubes, as described above for Fig. 6. Each plate in Fig. 7 is connected through a capacitor to the suppressor grid of the next clockwise tube. The suppressors are all connected to the cathode ring through resistors.

Due to these connections, the only "on" tube whose suppressor

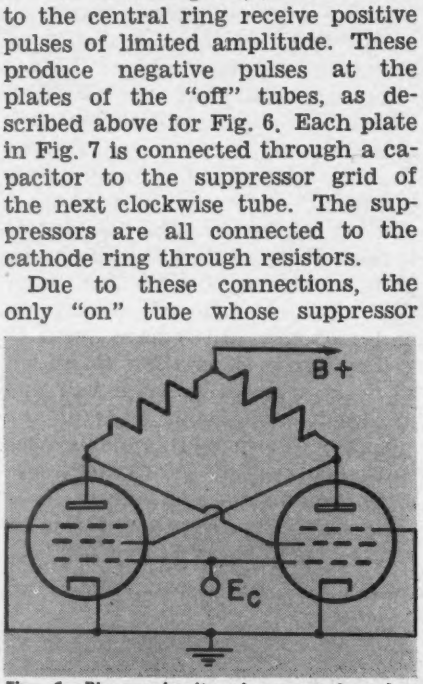


Fig. 6—Binary circuit using pentodes. Low screen voltage of the "off" tube prevents conduction

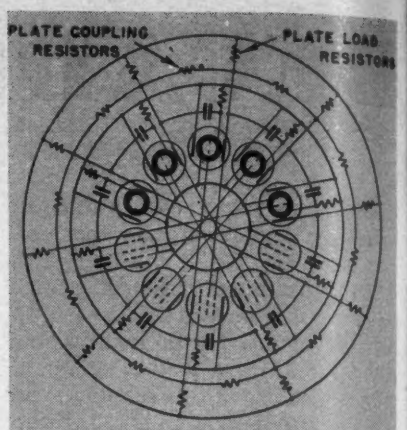


Fig. 7—Ring of 10 counter using pentodes. Each pulse supplied to the main control grid ring (center) causes the first clockwise "off" tube to go on and the last clockwise "on" tube to go off.

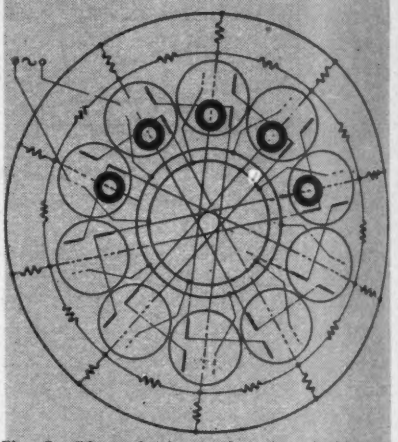


Fig. 8—Ring of 10 circuit using double pentodes and triggered by AC

receives a negative pulse is the left hand end tube. This goes out and its opposite partner goes on thereby advancing the group of "on" tubes one count around the ring.

Variations of this circuit can be used to trigger with alternating current.

This is an interesting possibility and is accomplished with conventional twin pentodes such as 12L8GT in a double ring of ten (Fig. 8). That is, the circuit embodies ten double pentodes. These tubes have common cathodes and screens and

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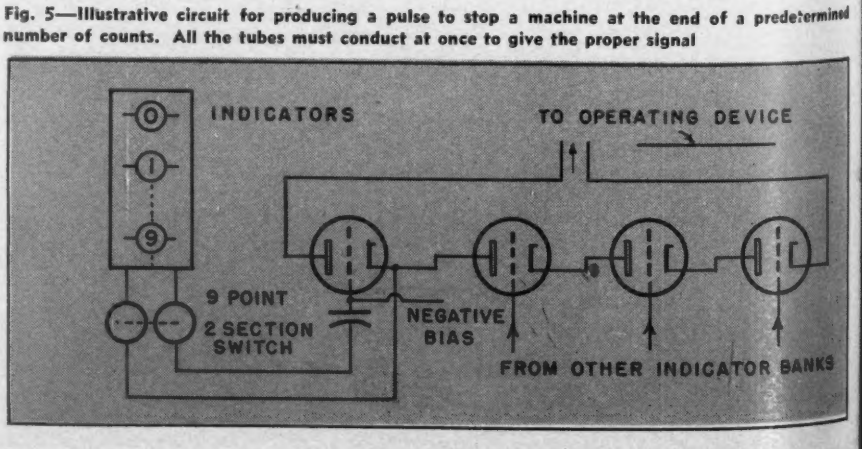
Fig. 5—Illustrative circuit for producing a pulse to stop a machine at the end of a predetermined number of counts. All the tubes must conduct at once to give the proper signal



WHAT INDUSTRY SEEKS IN ELECTRONIC CONTROL

Engineers of chemical, petroleum and food producers outline processing problems and their present instrumentation needs

CHEMISTS WANT SUPER RELIABILITY

By **PHILIP EWALD** Chemical Engineer, TVA, Sheffield, Ala.

• Chemists and chemical engineers do not need to be sold on the idea of using electronics in their instrumentation. They are ready to accept, in fact they expect, near miracles of measurement to be performed electronically. The invariable query involving a particularly tough problem is "Can't we do it with vacuum tubes or photo-cells?" This attitude stems from the already excellent record of electronics in instrumentation and familiarity with what is done in radio communication using a few dollars' worth of parts.

It also leads to over-optimism as in the case of the chemical engineer who wanted to measure high temperatures in his pilot plant at a minimum cost. He wanted a pyrometer constructed from a $3 meter movement and a couple of 50¢ vacuum tubes, which, according to his calculations, had enough amplification to operate the meter from thermocouples. He would be satisfied with a 2% maximum error, and was sure the job would not total more than $15.

Performance paramount

This confidence in electronics is quickly shaken by unreliable performance, particularly in chemical operations. For another example, a low-cost photoelectric turbidity control easily sold itself to an engineer designing a certain installation. Unfortunately it was a direct amplification affair with no balanced bridge or compensation, and was subject to all the vagaries of power line voltage, room temperature and humidity, and component fatigue. After a few days' struggle with the outfit and a couple of consultations with the instrument laboratory, the operator abandoned it.

Reliability is probably the chief problem of electronic instrumentation. The laboratory man may be content to restandardize his electronic instrument every few readings, but the plant man expects his to run for years with only periodic attention from the instrument laboratory. Good circuit design will not be enough where dirt and corrosion are problems as in most chemical plants. Ordinary tropicalization may, but probably won't, be ample protection. Many a beautiful amplifier and control assembly has been corroded out in a few days' time.

In producing electronic instruments for the chemical industry, the moral might well be—Do a circuit design job theoretically 100% correct, dustproof it, waterproof it, acidproof it, and then find out what else it needs.

OILMEN SEE EXPANDING UTILITY

By **L. C. ROESS** Beacon Research Lab., The Texas Co., Beacon, N. Y.

• Many instruments using electronic principles, either in whole or in part, have played an important role in research and testing in the petroleum industry. One of the most important, the mass spectrometer, used for the analysis of hydrocarbon gases is coming into use in the studies of hydrocarbon reaction mechanisms which employ heavy carbon (C^{13}) as a tracer element.

Desirable improvements in mass spectrometers would include increased stability and reproducibility in the behavior of the ion source, the use of a modulated ion source or ion beam to allow the dc amplifier following the electrometer tube to be replaced by an ac amplifier, and an increase in overall sensitivity. It is possible that a mass spectrometer based on the principle of the velocity selector, in which pulses of ions are produced by use of radar technics and the various masses separated by measuring the time of flight, could be developed which would have greater stability and reproducibility than the present instrument.

Another important analytical and research tool is the absorption spectrometer, using either ultraviolet or infrared radiation. Considerable improvement in radiation sources, radiation detectors and amplifiers, as well as the development of servomechanism controls to make the instrument operation essentially automatic would be very welcome. The development of much more stable light sources for use with Raman spectrographs, as well as of photomultiplier tubes with a lower dark current, would increase appreciably the accuracy of analysis using the Raman spectrograph. With respect to emission spectroscopy, while the petroleum industry is not faced with the problem of turning out large numbers of analyses of metals, it is following with great interest the development of automatically operating and recording prism and grating spectrographs in the visible region.

Because of the rather laborious calculations frequently encountered in the application of the methods mentioned above to hydrocarbon analysis, the petroleum industry is interested in the development of electronic computers to simplify the application of analytical methods. Although computers now available are excellent, still further increases in speed, and possibly in accuracy, are desirable.

There are a variety of instrumentation systems which now require the use of photographic recording

in order to obtain the desired high speed. The development of higher speed pen-and-ink or direct reading recorders would be of great value to the petroleum industry.

An application of electronics which is becoming of increasing importance to the petroleum industry is the use of amplifiers and electronic counting or scaling circuits with Geiger-Muller counters, both in the measurement of x-ray intensity and also in connection with the tracer studies using radioactive isotopes.

Counting circuits

Here this chief interest lies in the development of Geiger-Muller counters, amplifiers, and counting circuits having shorter resolving times, in order to obtain the increased accuracy and decreased observation time associated with higher counting rates. The carrying out of analyses of organic materials by the measurement of x-ray absorption by means of Geiger-Muller counters or fluorescent screen-photomultiplier combinations is an interesting field requiring further development. The Texas Company has been active in this field and has developed a new type of radiation detector characterized by extremely high sensitivity and reliability.

In the petroleum industry thousands of viscosity measurements are made daily. Although the problem is a difficult one, the development of a device which would permit routine viscosity measurements to be made almost completely automatically, and yet with the precision of the order of 0.1%, which is now commonly obtained, would be of tremendous value to the industry.

Microwave equipment

The application of microwave absorption as an analytical tool, as well as in research, is a field which is just beginning to be explored. It promises to be of great value to the petroleum industry, and electronic problems of the first order must be overcome before this powerful tool can be placed upon a routine basis.

In connection with the testing of fuels and lubricants, electronic devices are finding increasing applications. Knock meters for measuring the intensity of knock in engine cylinders, and pressure measuring and recording devices for recording pressure-time or pressure-volume curves are becoming more and more widely used. There is still plenty of room for electronic progress in this field, particularly the development of a simple and rigid pressure time indicator capable of being accurately calibrated and essentially independent of fluctuations in the engine temperature.

Since the piston temperature plays an important role in controlling oil deterioration in an engine, a knowledge of it is extremely important in interpreting engine tests of lubricating oils. Therefore, the development of an electronic means of measuring piston temperatures which would not involve the sliding or intermittent contacts which are such a troublesome feature of the methods now in use, would be of great value.

In view of the ever-increasing importance of finding new oil reserves, and of making optimum use of the oil reservoirs now producing, the development of improved methods of geophysical prospecting for new oil fields and of determining the location and capacity of producing sands would be valuable. There is an opportunity for the development of improved well-logging devices and seismic geophysical prospecting equipment.

In the well-logging field both gamma ray and neutron detectors are used. One of the desirable features of these devices is increased sensitivity of the detecting devices to permit more rapid survey of the bore hole, as well as greater freedom from errors due to high temperature in the well. For off-shore prospecting where the precise location of the drilling rig is important, a variety of radio locating devices which are capable of considerable precision are available.

Corrosion problems

The problem of pipe-line and storage tank corrosion is a perennial one which offers a considerable field for the development of electronic devices for the measurement of the electrical conditions causing corrosion and for the application and control of cathodic protection. There is a need for improved pipeline locating devices, especially one capable of picking out a particular line in a conjested area in which many other lines are located near the desired line, or an instrument capable of locating deeply laid lines.

The application of electronic plant control devices in the refinery is still in its infancy, presumably due to the fairly adequate job done by the pneumatic or hydraulic control systems now used. As the number of refinery processes calling for more accurate control of more complex operations increases, superior

(*Continued on page* 116)

FOOD INDUSTRY BETTERING QUALITY

By HAROLD K. STEELE Fleischman Laboratories, New York

• Color is one of the important characteristics of many food products. Although there are now available many color measuring instruments ranging from simple color comparators to precise spectrophotometers, none are satisfactory. The industry needs a sensitive, rugged and foolproof device which can be used for making objective color determinations on all classes of products. The color difference between top quality and ordinary quality is often quite small when measured with the instruments available today, but is none the less visible to the eye of the buying public.

In processing many foods, rapid heating is essential for the production of a top quality product. High frequency heating has been sucessfully used in some instances, but is still too expensive to have wide application. An electronic blancher that would heat whole fruits or vegetables to the proper temperature for enzyme inactivation in a few seconds while the product was moving on a conveyor belt is but one of many interesting possibilities. In addition, this form of energy could be used for baking, cooking, dehydration, defrosting, melting, etc., provided efficient and economical equipment can be developed for its production.

The determination of moisture is another test for which electronic methods might be further developed. There are already some instruments produced for this purpose, but they are not in general use. Many products are cooked to a definite moisture content. A rapid automatic control system for such products would almost certainly result in improved quality and lowered costs. Such a control system would be invaluable in the food dehydration industry.

The list of applications for improved electronic methods could be extended indefinitely. There is hardly a process in the food industry that could not be improved by the use of electronic methods.

THERMAL DETECTORS

Newest types of temperature units having extreme sensitivity find numerous uses with radiation indicators in industry

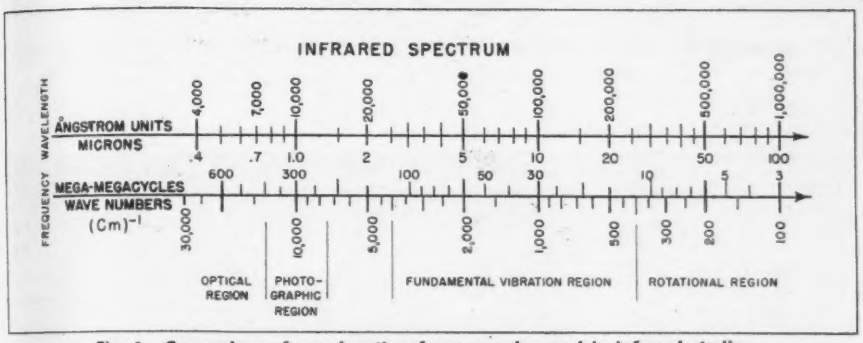


Fig. 1—Comparison of wavelength reference scales used in infrared studies

• In numerous diversified fields of research and measurements, there has been a need for increased sensitivity in a thermal radiation indicator. Developments along several lines have resulted in notable extensions to the measuring range of these devices. Most of these advances have been electrical in nature, which makes them particularly adapted to electronic amplification for making smaller variations known or for operating recorders or controllers.

Resistance thermometers, called bolometers, thermistors, etc., represent one class of instrument either capable of taking note of extremely small changes in resistance, or containing materials that exhibit large changes in resistance with small values of incident heat. Some use has been made of the phenomenon of super-conductivity exhibited by many conductors at temperatures approaching absolute zero.

In some materials such as tantalum the transition between the normal conductivity and superconductivity states occurs quite abruptly at a definite point (that is reversible) along the temperature scale. If the ambient temperature is critically controlled to within this transition range—(possibly .01 to .02 degree) any small amount of heat applied will cause enormous changes in the relative resistance. This interesting discovery made the phenomenon so valuable a method of measuring small amounts of heat that the difficulties of producing the necessary precisely regulated temperatures between 14° and 16° Kelvin were overcome.

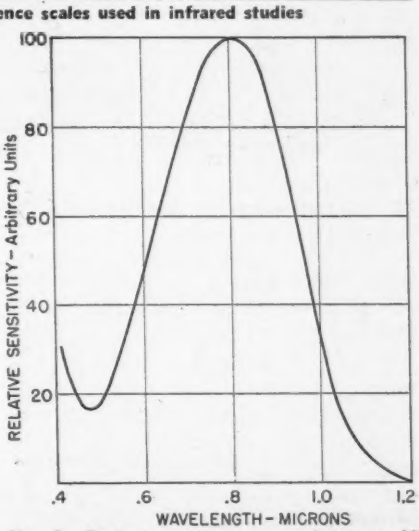


Fig. 2—Typical spectrum curve for type S2 photoelectric surfaces

Another class of bolometer includes thermocouples which deliver a potential in accordance with the laws of Peltier and those of Kelvin. While thermocouples are still serving mainly in applications where sensitivity is not a factor, some work has been done at low ambient temperatures where the sensitivity characteristic is improved because of the increased thermoelectric power and a better resistivity/ absolute temperature factor. Other improvements have been along the line of better adaptation to amplification circuits.

Radiometers generally utilize effects of incident heat other than resistance changes. Photoelectric amplification of torsional movements has been used. Developments along the principle of the Hays cell have also greatly increased its sensitivity. Here the absorption of heat by gas filling of the cell alters the contour of a thin film which forms on one wall of the container.

Another method of approach has been to extend the range of photoconductive cells into the infrared region. (See Fig. 1). One, a lead sulfide cell is capable of operating

(*Continued on page* 116)

Fig. 3—Dr. J. A. Baker (Bell Laboratories) demonstrates form of flake graphite bolometer having extremely high sensitivity

RADIOACTIVITY METER

By ARTHUR G. BOUSQUET
General Radio Co., Cambridge, Mass.

Electronic engineering makes another contribution to the development of atomic energy for constructive purposes

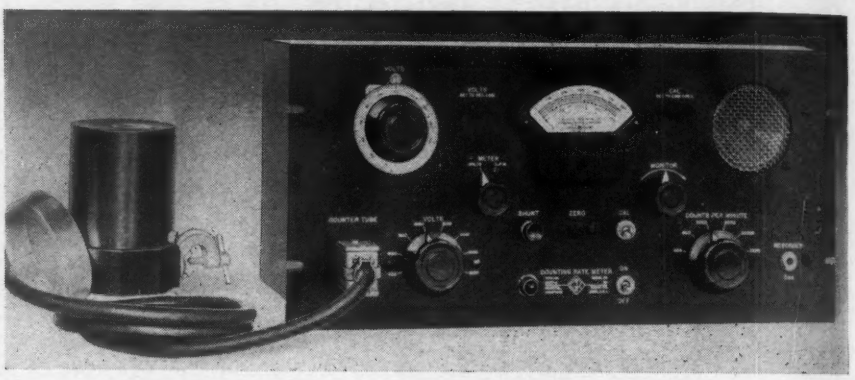


Fig. 1—Panel view of the type 1500-A meter with its associated pre-amplifier and probe assembly

• With nuclear research and nuclear engineering programs rapidly being formulated by universities, hospitals and various industrial and government groups, the need for instrumentation in this comparatively new field has increased the importance of the Geiger counter and its associated equipment. The Geiger counter is used to detect and count the bursts of energy and the particles which are emitted from the nuclei of radioactive materials. Two familiar applications are the quantitative measurement of radioactive materials and cosmic ray research.

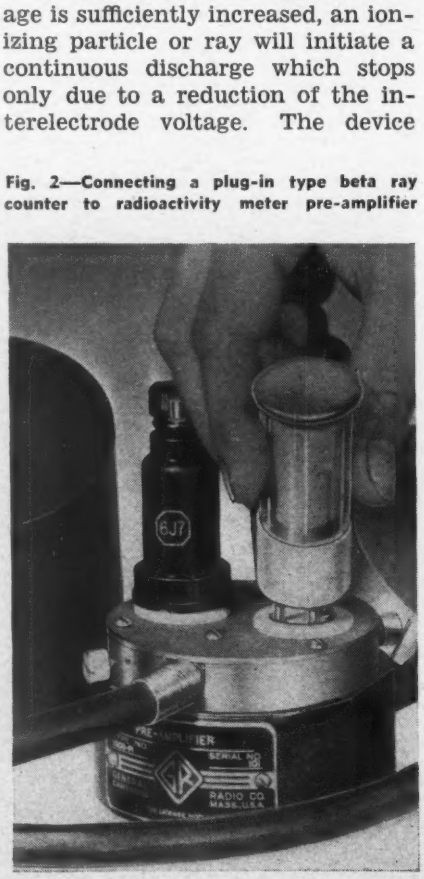
A most promising field is in conjunction with radioactive isotopes, since the advent of the cyclotron has made possible the production on a usable scale of several hundred such isotopes. The radioactivity of these isotopes provides a tracer, by means of which their course in chemical and physical processes can be followed with the counting-rate meter. The present applications of this technic include problems in medicine, chemistry, geology, meteorology and agriculture. In industry also this counter has been found useful—notably in petroleum prospecting.

The development of the counting rate meter described in this article was started before the war as a cooperative endeavor by interested groups at Massachusetts Institute of Technology and the General Radio Co. Several such instruments have seen service in various projects during the war and improved designs are now being produced on a commercial basis.

Counter operation

If a low voltage is applied to two adjacent electrodes in an ionized gas, the positive ions will be attracted toward the negative electrode and the negative ions will migrate to the positive electrode. If the voltage is just sufficient to draw the ions out of the area, the device is called an ionization chamber and the current flow is a measure of the number of ions in the field. However, if the applied voltage is sufficiently increased, an ionizing particle or ray will initiate a continuous discharge which stops only due to a reduction of the interelectrode voltage. The device operating under these conditions is called a Geiger counter.

Fig. 2—Connecting a plug-in type beta ray counter to radioactivity meter pre-amplifier



If a large resistance is placed in series with the voltage source and the Geiger counter, the discharge will quench itself. This is because the electrons produced in the gas by ionization move with high velocity to the positive electrode, altering its potential and leaving a slowly moving positive ion sheath which then travels to the negative electrode. The high resistance prevents the potential of the positive electrode from recovering before all positive ions (which might start new discharges) have been neutralized. A similar quenching action may be obtained by means of vacuum tube circuits.

As a result of this quenching action, each discharge pulse is an indication that a charged particle has entered the counter. Furthermore, there is a regulatory action so that the counter may be operated over a voltage range where the current due to an ionization cycle will be fairly constant. The center of this current "plateau" is the usual operating point of the Geiger counter. Proper counter design is concerned with the resolving time or speed with which the quenching action takes place, its freedom from temperature and humidity effects, the broadness of the plateau, stability,

FOR NUCLEAR RESEARCH

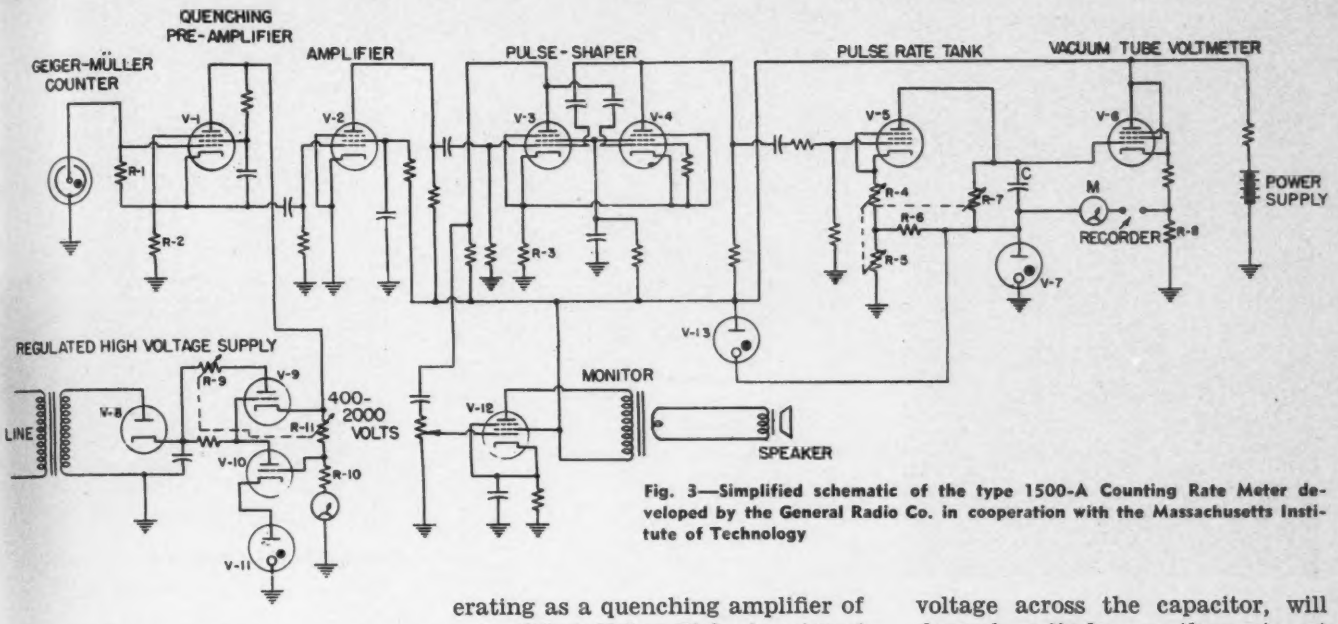


Fig. 3—Simplified schematic of the type 1500-A Counting Rate Meter developed by the General Radio Co. in cooperation with the Massachusetts Institute of Technology

aging characteristics, efficiency and life.[1]

In the counting-rate meter to be described, the discharge pulses produce a voltage which indicates at any moment the rate per minute of the incoming pulses. With a voltmeter actuating a pen-and-ink recorder, a running record is obtained, showing the past and present history of the radioactive emissions.

This meter is shown in Fig. 1 and a close-up of a beta-ray counter with its preamplifier is shown in Fig. 2. The plug-in type counter and its preamplifier are housed in a separate small compartment at the end of a cable to provide greater flexibility of operation.

Circuit description

In the circuit of Fig. 3 the Geiger counter is placed in series with R-1 and V-1, the anode of V-1 being connected to an electronically regulated voltage supply consisting of V-9, V-10 and V-11. In the absence of radiation, little or no current flows in R-1, leaving the grid essentially at zero bias with a consequent low voltage drop across the anode circuit and a relatively high voltage across the Geiger tube.

When gas in the Geiger tube becomes ionized as the result of bombardment by nuclear particles, a current flow takes place that can be stopped, or "quenched," only by reducing the applied voltage. This reduction is performed by V-1, operating as a quenching amplifier of a modified Neher-Pickering type.[1] Any current flow through R-1 will increase the grid bias of V-1, thereby reducing the anode current and lowering the voltage drop across the Geiger tube below the critical value required for continuous discharge. This restores the circuit to its quiescent state to await the next impulse. The speed at which V-1 is able to perform its quenching and voltage restoring function safely exceeds the transit time characteristics of the best available Geiger counters.

The output at the cathode of V-1 consists of a sharp negative pulse which is amplified by V-2 and shaped by V-3 and V-4, appearing at the output of V-4 as a greatly amplified positive pulse. Since from this point there is regenerative feedback to the grid of V-3, the output pulses will depend only in their time distribution on the input pulses, but will all be identical in shape and magnitude.

The integrator tube, V-5, is biased beyond cutoff. Each positive pulse appearing at its grid causes a definite amount of current to flow in the anode circuit; hence, the capacitor C in the anode circuit will absorb a definite quantity of charge for each incoming pulse—an intergrating process. The resistor R-7, however, introduces a differentiating factor, since it allows the impounded charge to leak out of the capacitor at a given rate dependent on the RC time constant. The residual charge, as indicated by the voltage across the capacitor, will depend entirely on the rate at which charging pulses have been coming in, since these pulses are all of equal amplitude and duration.

The pulse rate, in counts per minute, is indicated by a vacuum tube voltmeter[2] connected across capacitor C. This capacitor has been specially wound with polystyrene tape to reduce to a negligible value the effect of its dielectric absorption on the accuracy of differentiation.

The full scale meter current is 5 ma., suitable for operation of most ink recorders, and the range of pulse rates is extended by using different values of bleeder or differentiating resistors at R-7 and by varying the amount of degeneration caused by R-4 in the integrator tube. Full scale ranges of 200, 600, 2000, 6000 and 20,000 counts per minute are thereby obtained. A monitoring loud speaker, shown schematically in Fig. 3, is provided for convenient estimation of the counting rates.

The voltage supply to the counter may be adjusted to any value between 400 and 2000 volts and is electronically regulated to maintain the operating voltage of the Geiger counter at a fixed point near the center of the useful portion of its characteristic plateau.

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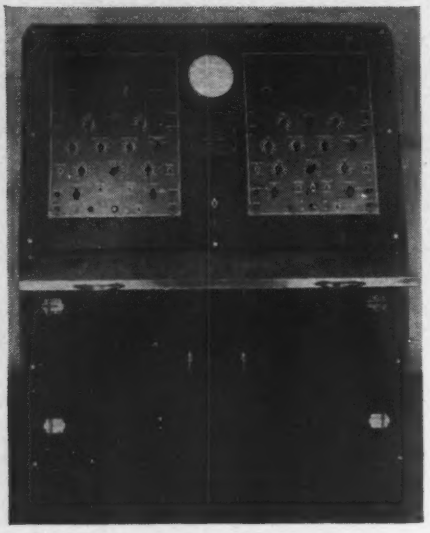
[1] "Electron and Nuclear Counters—Theory and Use," Korff, D. Van Nostrand Co., Inc.

[2] U.S. Patent No. 2,374,248.

See also "Design and Operation of an Improved Counting Rate Meter"—A. Kip, A. G. Bousquet, R. D. Evans and W. N. Tuttle. Review of Scientific Instruments, Vol. 17, No. 8 (August, 1946).

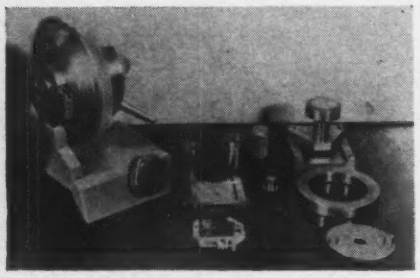
FOR RESEARCH

What's New for the Industrial Laboratory



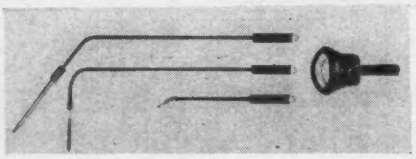
Dual-Channel Oscilloscope

The Electronic Tube Corp., 1200 E. Mermaid Ave., Chestnut Hill, Philadelphia 18, has developed a line of two-channel oscilloscopes for simultaneous display of two phenomena on a single cathode-ray tube screen. Type E-2G47 comprises two standard oscilloscopes coupled to a special dual-gun cathode-ray tube. Independent control of intensity, focus, trace position, sweep rate and deflection sensitivity is possible, since each channel contains its own X, Y and Z axis amplifiers, time base oscillator and power supply. Terminals in the rear permit direct connection to all eight deflection plates as well as the two second anodes.—Electronic Industries



Micro X-Ray Diffraction Camera

As an accessory to the Norelco X-Ray diffraction unit, the North American Phillips Co., Inc., 100 E. 42nd St., N. Y., has designed a special camera that permits detailed study of very small areas of the materials under X-ray examination. The equipment includes a demountable camera unit, the film cassette of which is provided with a beam stop as well as a hose connection for evacuation or gas filling of the film chamber. Special holders enable examination of specimens requiring tension, as well as microtomed sections and other flat objects. The camera kit is supplied complete with a microscope adapter, extra film spacer, wrenches, film punch and instructions, packed in a special instrument case.—Electronic Industries

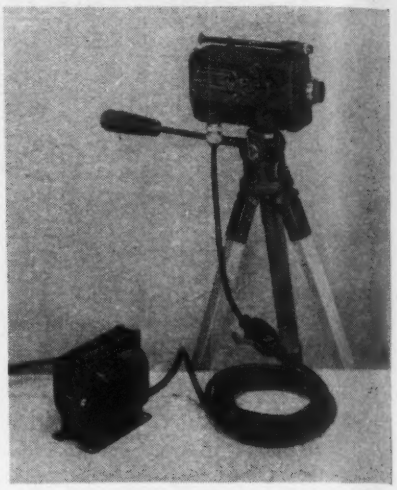


Portable Pyrometer

A portable pyrometer with a choice of plug-in angle extensions has been designed by Wheelco Instruments Co., 847 W. Harrison St., Chicago, Ill. The instrument permits use of a variety of thermocouples by means of straight, 45° or 90° angle extensions. The high resistance meter has scales calibrated from 0° to 600°F for dual iron-constantan and from 0 to 1600 or 2500°F for dual chromel-alumel. Centigrade equivalents are shown on the dial.—Electronic Industries

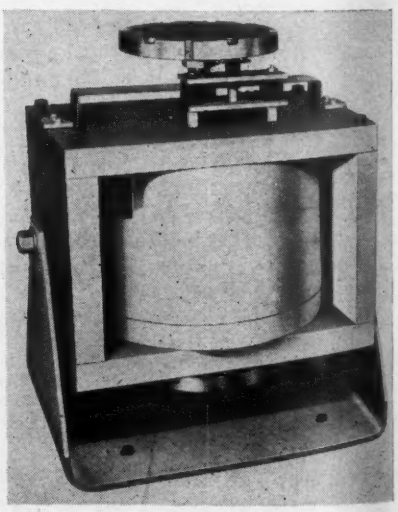
Wide Range V-T Voltohmmeter

The Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif., has a new Model 410A high frequency vacuum-tube voltmeter, incorporating a special probe diode tube developed by Eimac for this instrument. The probe input capacity has been reduced to 1.3 mmfd, permitting measurements from 20 c/s to 700 mc. An effective ac impedance of 6 megohms is maintained up to 10 mc while the input resistance on dc ranges is 100 megohms. The instrument measures up to 300 rms volts, 1000 dc volts and 500 megohms.—Electronic Industries



High-Speed Camera

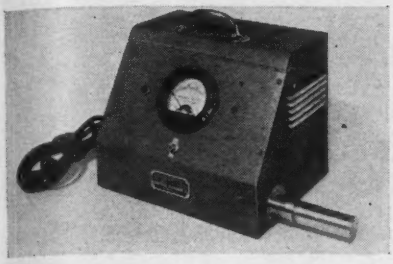
For time and motion study work Bell and Howell Co., 7100 McCormick Rd., Chicago 45, Ill., has brought out the Filmo "Electro" motor-driven 16 mm motion picture camera. The camera is equipped with a 21 mm F 1.9 lens with viewfinder and matching objective. Operating speeds are 1000, 2000 and 4000 frames per minute with calibration in multiples of 1000 frames per minute. A transformer is provided for operation on the ac supply line.—Electronic Industries



Shake Table

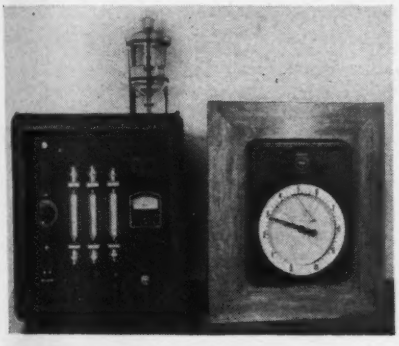
A source of synthetic vibration for testing resonant modes of mechanical structures has been developed by the Vibration Division of the MB Mfg. Co. Inc., 333 East St., New Haven 11, Conn. Known as the MB vibration exciter and calibrator, this machine has an 8.5 in. diameter table driven by an electro-magnetic vibrator motor capable of imparting forces up to 200 lbs. peak having a maximum excursion of one inch. Mounted on a pivoted cradle, the table and motor are operated by separate motor driven alternators (not shown) which provide variable frequency excitation of the vibration motor over a range from 3 to 500 c/s. The motion of the table is sinusoidal and a signal coil provides an output reference voltage for use in calibrating vibration pickups.—Electronic Industries

AND DEVELOPMENT



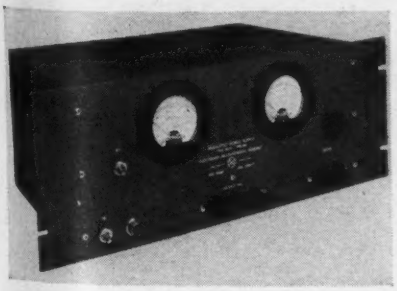
Radiation Intensity Meter

An instrument that serves as indicator of radioactive intensity and gives an audible warning signal when maximum safe dosage values are exceeded, has been developed by Geophysical Instrument Co., Arlington, Va. The device is unaffected by line voltage changes of plus or minus 15 volts. A switch for checking calibrations is provided The unit consumes 40 watts at 115 V., 60 cycle.—Electronic Industries



Contamination Checker

Contamination of the atmosphere through carbon tetrachloride, trichlorethylene, chloral etc. may be checked by use of the Westvaco halogenated hydrocarbon analyzer offered by Industrial Instruments, Inc., 17 Pollock Ave., Jersey City, N. J. The semi-portable unit operates on 115 volt, 60 cycle ac supply and consumes approximately 1000 watts. Distilled water is used at a rate of less than 1 liter per hour. Hydrogen consumption is approx. 1 cft. per hour of normal operation.—Electronic Industries



Regulated Power Supply

Electronic Measurements Co., Red Bank, N. J. offers model 200B power supply for operation on 105 to 125 V. ac 50-60 cycles. The unit supplies 0-325 V. dc at 125 ma and 6.3 V. at 6 amps., unregulated. Regulation of the unit is 1% for voltages between 20 -235 volts from no load to full load and for line voltage variation from 105 to 125 volts at full load. Power consumption at full load is 220 watts.—Electronic Industries

Reflection Meter

Spectral reflectance characteristics of materials may be determined by use of the reflection meter in production at General Electric Co., Schenectady, N. Y. The instrument consists of an optical system for viewing the sample, two type PJ-22 vacuum phototubes, an amplifier tube with plate current meter, and nine narrow-bandpass filters for isolating parts of the spectrum. The unit is usable throughout the visible range and has a precision of 0.1% on samples having reflection values from 50 to 100%. Operates on 8 amp., 6 V. storage battery and 135 V. "B" batteries.—Electronic Industries

Photoelectric Colorimeter

For measuring light transmission of liquids in Nessler tubes the Lumetron colorimeter (Model 450) is offered by Photovolt Corp., 95 Madison Ave., New York. The photoelectric instrument utilizes a light beam passing vertically through the long liquid column making it particularly suitable for measurement of samples of pale colors or faint turbidity.—Electronic Industries

Fluoroscope

An auxiliary fluoroscope to be used in conjunction with the Searchray 150 unit is being offered by North American Philips Co., 100 E. 42 St., New York. Consisting of a collapsible pipe framework with auxiliary fluoroscopic screen, the device makes it possible to reduce the distance between specimen and tube target to approx. one-half, thus quadrupling screen intensity and improving the clarity of the image.—Electronic Industries

Capacitor Analyzer

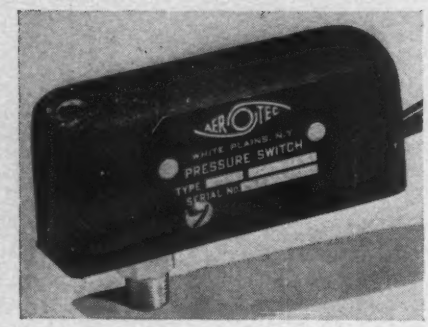
Model CF EXAM-ETER, manufactured by the Solar Mfg. Corp., 285 Madison Ave., New York 17, is a capacitor analyzer combining a Wien bridge for capacitor measurement and a Wheatstone bridge for resistance measurement with an ac-dc vacuum-tube voltmeter. The instrument measures capacity from 10 mmf to 2000 mf, power factors from 0-55%, resistance from 100 ohms to 10,000 megohms and has dc voltage ranges up to 550 volts and ac voltage ranges to 50 volts. Shorted, open or intermittent capacitors can usually be located without removal from the circuit and without turning off power to the equipment under test. Leakage current of electrolytic capacitors may also be read on the 4½ in. recessed meter, using a self-contained test voltage source adjustable from 0 to 550 dc volts.—Electronic Industries

Insulation Resistance Tester

An insulation resistance tester with a range from 0 to 100 megohms which does not require any external power supply is in production at Ideal Industries, Inc., 5194 Park Ave., Sycamore, Ill. A test voltage of 500 volts dc is provided by a small internal hand generator. An electronic voltage regulator controls the voltage at the meter. —Electronic Industries

NEW COMPONENTS

What's New in Instrument Parts and Accessories

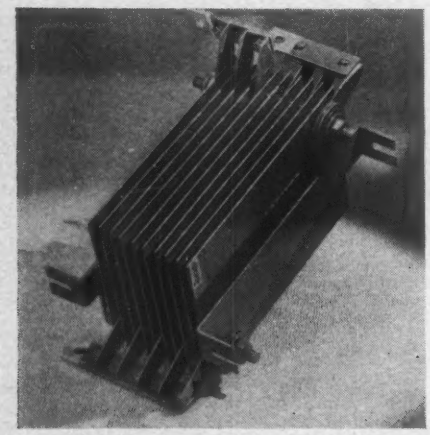


Pressure Switches

Three pressure switches of the fixed differential, adjustable differential and reset type for pressure control applications are being marketed by Aerotec Co., White Plains, N. Y. The units consist of a microswitch rated 100-115 v ac, and a pressure mechanism of the metal bellows type. The switches are available for a wide variety of pressure ranges and contact arrangements.—Electronic Industries

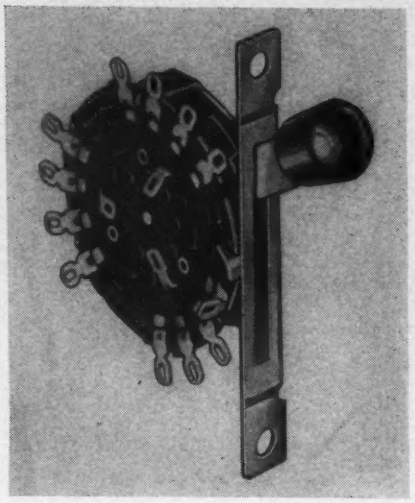
Four Gun CR Tube

For industrial applications requiring four separate signal indications the 5Z4P type cathode ray tube has been developed by Electronic Tube Corp., 1200 E. Mermaid Ave., Philadelphia 18, Pa. The tube has a 5 in. screen, electrostatic deflection and focus and is available with screen phosphors P1, P2, P4, P5, P7, P11 and P12. Deflection plates are brought out to 16 separate terminals and a 27 pin special base is used. —Electronic Industries



Heavy Duty Selenium Rectifier

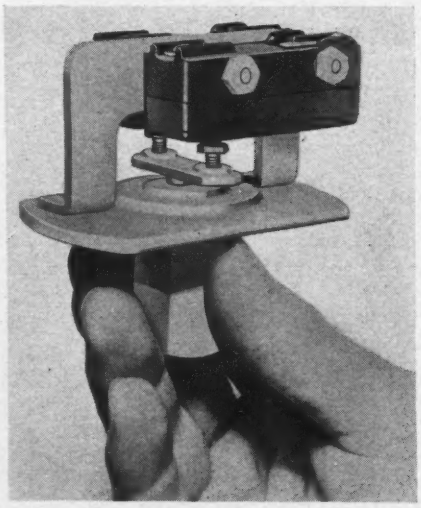
A heavy-duty selenium stack with 26-volt plates, double studs and center contact construction is in production at Federal Telephone and Radio Corp., Newark, N. J. Rectangular, square-cornered plates are used for the stack, which may be mounted in a vertical or horizontal position.—Electronic Industries



Switches

A new line of lever action switches, series 5000 and 6000, is being manufactured by P. R. Mallory and Co., Indianapolis 6, Ind. The switch has a total of 26 circuit combinations including two, three and four positions. Contacts will make and break 120 ma at 110 volts dc or 50 ma at 250 volts dc and will carry 10 amps. without excessive heating.—Electronic Industries

Additional new products for Instrumentation are described on following pages and also on pages 106, 108 and 110.

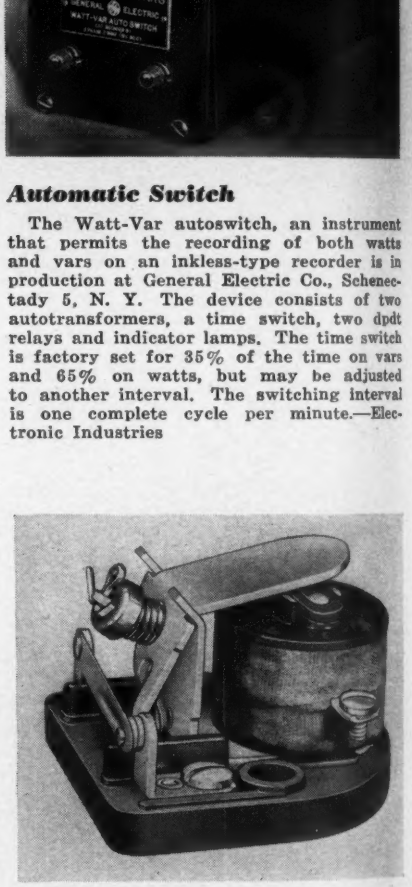


Differential Switch

A two section pressure switch has been developed by Cook Electric Co., Bellows Devices Division, 2700 Southport Ave., Chicago 14, for controlling two separate circuits in response to pressure differentials. Operating on pressures from 1 to 17 psi, the "ID" type switch may be supplied with either element adjusted to on-off differentials from 1 to 10 psi. Maximum current rating is 10 amps. at 120 volts ac and the pressure connection fits standard ¼ in. female pipe threads. The enclosed, snap action contacts are calibrated to order, but may also be adjusted after installation. Similar switches can be supplied for operation on pressures up to 200 psi.—Electronic Industries

Automatic Switch

The Watt-Var autoswitch, an instrument that permits the recording of both watts and vars on an inkless-type recorder is in production at General Electric Co., Schenectady 5, N. Y. The device consists of two autotransformers, a time switch, two dpdt relays and indicator lamps. The time switch is factory set for 35% of the time on vars and 65% on watts, but may be adjusted to another interval. The switching interval is one complete cycle per minute.—Electronic Industries



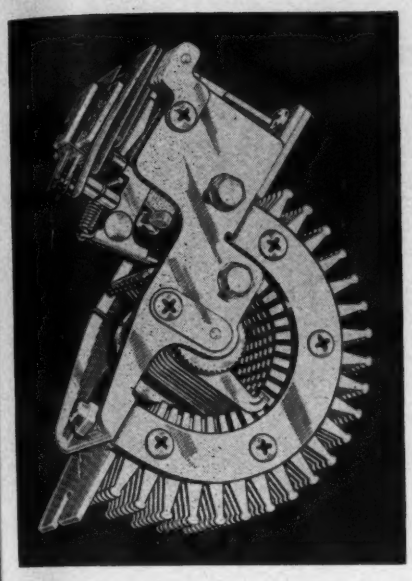
Motor Starting Relay

A voltage actuated motor starting relay, which operates on the back voltage of the starting winding, has been brought out by Potter and Brumfield Mfg. Co., 549 West Washington Blvd., Chicago 6, Ill. After the motor has attained the proper speed the relay disconnects the starting coil from the line. The relay operates over a wide range of line voltage variations. It may be mounted on the motor housing or located at a distance.—Electronic Industries

Pilot Light Assemblies

A series of pilot light assemblies fitted with lightshields to permit direction of a beam of light at any angle is available from Dial Light Co. of America, 900 Broadway, New York 3. Housing and shield of the unit are brass and models with different sizes of shield openings for change in illumination are available. The series is provided with a built-in resistor for use with NE-51 Neon lamps on 110 and 200 volt circuits.—Electronic Industries

for INSTRUMENTATION

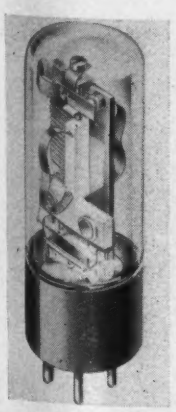


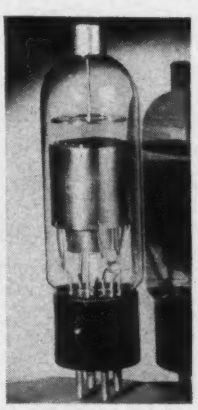
Stepping Switch

A spring driven stepping switch which, in conjunction with an impulsing device, will select any one of 20 or 40 channels and may be used for sequencing, counting and totalizing operations is being offered by C. P. Clare Co., 4719 West Sunnyside Ave., Chicago 30, Ill. Max. operating speed is 60 steps per second with 8 contacts available for a 20 point switch and 4 contacts for a 40 point switch.—Electronic Industries

Thermal Delay Relay

Time delay and control functions are combined in the model 501 thermal delay relay being manufactured by Instrument Div., Thomas A. Edison, West Orange, N. J. Accurate timing is possible with preset delay periods from 2 seconds to 8 minutes. The relay is supplied with either normally open or normally closed contacts and is rated at 6 amps up to 450 volts ac or 250 volts dc.—Electronic Industries Below, left



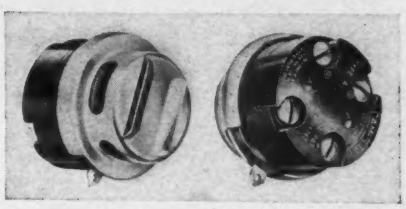


Grid Control Rectifier

Electrons, Inc., 127 Sussex Ave., Newark 4, N. J., has brought out a grid control xenon gas rectifier tube, type EL C3J. The tube has a filament voltage of 2.5 volts, filament current 9 amps., peak forward voltage of 750 v., average dc of 2.5 amps. and a peak plate current of 30 amps.—Electronic Industries

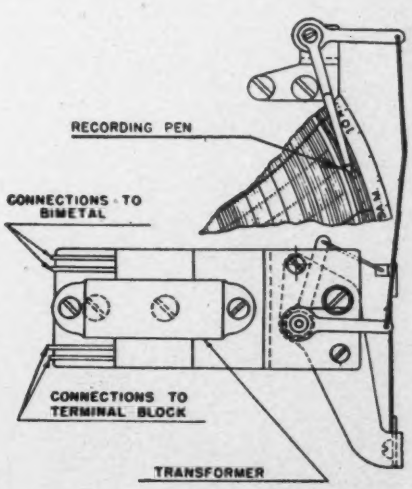
Solenoid Valve

Distillation Products, Inc., Rochester, N. Y., has developed a solenoid valve for high vacuum equipment designed to be used in conjunction with a recording potentiometer. The valve is normally held in an open position, but closes instantly when the electromagnet is energized. It operates on 110 v dc.—Electronic Industries



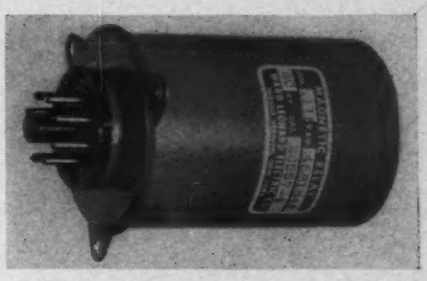
Thermostat

A small general purpose thermostat for 120 to 240 v ac with a current carrying capacity of 1500 volt-amperes has been designed by Cam-Stat, Inc., 2037 South La Cienega, Los Angeles, Cal. The units are 1 9/16 in. in diameter and 1 7/32 in. in depth and may be had for a variety of temperature ranges from —50 to 350° F.—Electronic Industries



Process Recording Pen

An auxiliary pen for industrial process recorders is available from the Brown Instrument Co., div. of Minneapolis-Honeywell Regulator Co., 4515 Wayne Ave., Philadelphia 44, for attachment to standard Brown instruments. It records on-off cycling of power circuits for energizing pumps, compressors and other equipment, producing a trace that may be correlated with graphs of major process variables recorded on the same chart. It is actuated by a bimetallic strip which warps in response to the passage of current, producing a deflection of about 3/16th in. at 3½ amps., the maximum current rating. Response lag is 10 seconds for maximum "on" deflection and 30 seconds for return to "off" position.—Electronic Industries

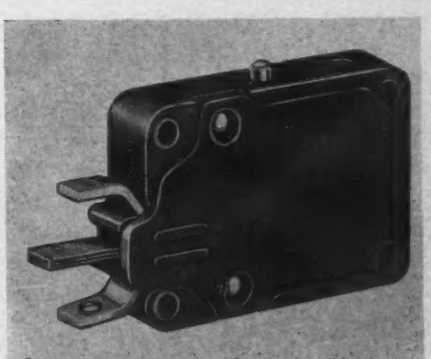


Heavy Duty Relays

Ward Leonard Electric Co., Mt. Vernon, N. Y., is manufacturing "Bulletin 130" relays for heavy duty industrial applications such as light contactor duty, control of single phase motors and other remote or automatic control purposes. Contact arrangements are available from one to four poles, normally open or closed, single or double throw. Operating voltages for dc relays are from 6 to 230 volts and for ac from 6 to 440 volts.—Electronic Industries

Flash Capacitor

The Speed-Pak Capacitron, an energy storage capacitor for high-speed repeating flash bulbs is being offered by Capacitron Co., 849 North Kedzie Avenue, Chicago 54, Ill. The unit, to be mounted behind the flash reflector, is hermetically sealed, oil dielectric. —Electronic Industries



Miniature Switch

An improved snap-action switch is in production at Acro Electric Co., 1308 Superior Ave., Cleveland 14, Ohio. Model "M" is for single and multiple assemblies with single pole, single or double throw contacts rated at 10 amps, 125 volts ac.—Electronic Industries

FOR CONTROL

What's New in Industrial Instruments

Selenium Rectifier

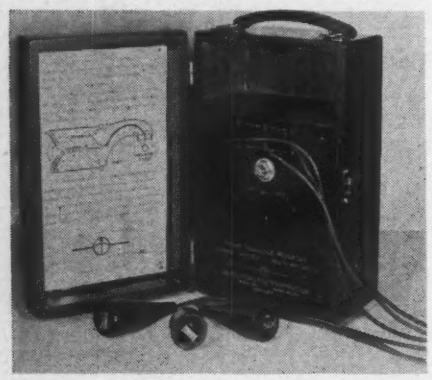
The Spectrifier—a power supply utilizing a full wave selenium rectifier for electroplating applications—has been brought out by Special Chemicals Corp., 30 Irving Place, New York 3. The rectifier provides an output of 6 volts at 100 amps. and operates directly from the 110 volt, 60 cycle, ac supply line. Power consumption is approx. 1100 watts.—Electronic Industries

Induction Heaters

Two new models of electronic power generators of 2 and 15 KW output for heat treating, brazing and soldering are available from RCA Victor Division, Camden, N. J. The illustrated 2 KW unit, model 2-BL, operates at a frequency of 400 kc and is shown complete with applicator unit, generator and foot switch. The 15 KW unit, model 15-BL, has the applicator unit with output current transformer and associated hf elements in a separate console.—Electronic Industries

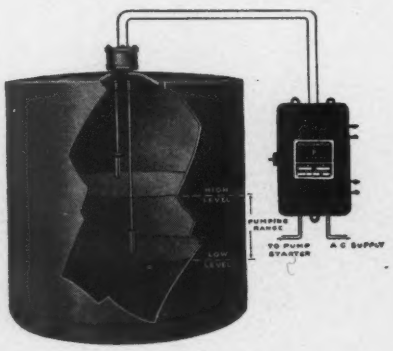
Photo Timer

Model TM-5-R electronic photo timer for operation with a remote control foot-switch has been developed by Lectra Laboratories, 30 E. 10 St., New York. The unit provides 55 time intervals from .2 to 11 seconds and 50 intervals from 11 to 60 seconds. Accuracy is within .05 sec. or 10% of the pre-set interval. The timer operates on ac or dc.—Electronic Industries



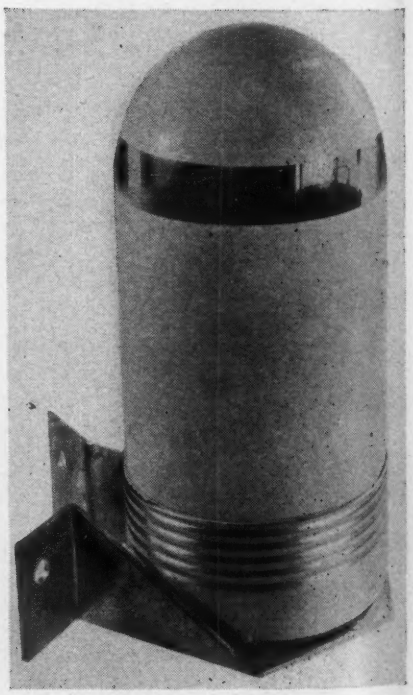
Phase Sequence Indicator

To identify the leading and lagging terminals of a three-phase source of electric power, the Measurements Corp. of Boonton, N. J., has produced a simplified phase sequence indicator having no moving parts. In operation, one terminal of any 220 to 600 volt three-phase supply is connected to the resistive arm of a "Y" type network in the instrument, while the other two terminals are connected respectively to inductive and capacitive arms of the network. By means of a panel switch the reactive arms may be interchanged to place the leading and lagging currents in the resistive arm in either aiding or opposing phase. When in aiding phase, sufficient voltage is developed across the resistive arm to light a gaseous discharge tube connected across this arm. The phase sequence of the terminals is then indicated by the position of the panel switch. The determination of phase sequence is essential to proper connection of the polyphase motors frequently used on industrial equipment, as well as for the operation of watt-hour, power factor and VAR meters on three-phase lines.—Electronic Industries



Level Control

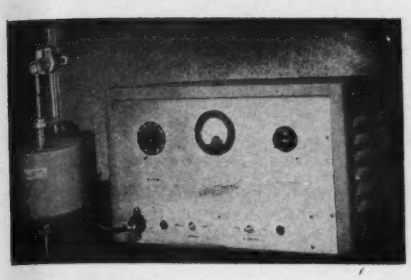
Photoswitch level control series 10 for controlling the level of all electrically conductive liquids is in production at Photoswitch Inc., Cambridge 42, Mass. The floatless control operates with low voltage in the probe circuit and may be matched to the specific resistivity of the liquid. A single pole, double-throw relay is provided in the output of the unit which is designed for operation on 115 or 230 volt 50/60 cycle ac.—Electronic Industries



Multiple Street Light Control

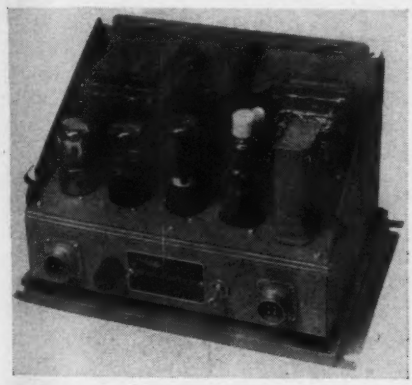
A photoelectric control for multiple street lights, which will operate for any preset value of sky illumination from ½ to 6-ft. candles, is in production at Fisher-Pierce Co., 82 Ceylon St., Boston 21, Mass. The control functions over a voltage range of 105 to 130 at 50 to 60 cycles and has an incandescent lamp load capacity of 500 watts. It consumes 6 to 7 watts.—Electronic Industries

AND PROCESSING



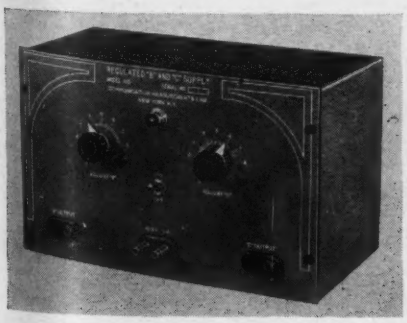
Bench Welder

A stored energy self forging bench welder for spot welding of similar or dissimilar metals and alloys is in production at Vangtronic Corp., 87 Washburn St., Bridgeport, Conn. The welder permits a speed from 30 to 180 spots per minute. It operates on 110 to 120 volt, 60 cycle, ac.—Electronic Industries



Line Voltage Regulator

An addition to a line of ac line voltage regulators is the model 500 now in production at Sorenson and Co., Stamford, Conn. The regulator will maintain output voltage within ±0.5% of adjusted value for variations of input voltage from 95 to 125 and load variations from 50 to 500 va. The unit operates independently of frequency variation up to 10%, has harmonic distortion of less than 5% and a transient recovery time of approx. 4 cycles.—Electronic Industries

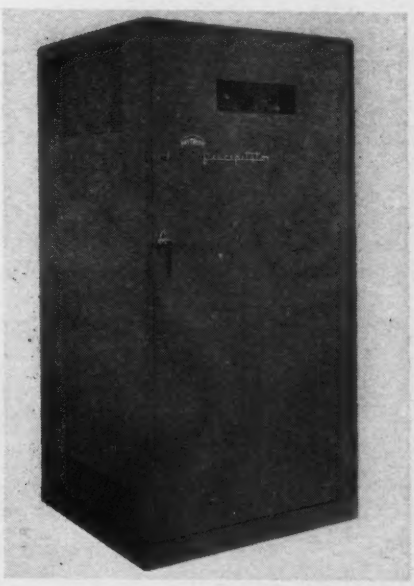


Dual Power Supply

Two independent regulated power sources are provided by the CML 1115 dual power supply developed by Communication Measurement Laboratories, 120 Greenwich St., New York, N. Y. A continuously variable dc voltage from 180 to 300 volts at 70 ma with a ripple of less than 25 MV is available for plate supply. Grid bias is furnished continuously variable from 0 to 75 volts with less than 7 MV ripple.—Electronic Industries

Process Timer

A utility process timer (Type TA) which has a synchronous motor that actuates a pair of heavy silver contacts rated at 1000 watts load has been brought out by Potter and Brumfield Sales Co., 549 West Washington Blvd., Chicago 6, Ill. Available in time cycles from 0-15 minutes up to 0-12 hours, the timer may be set to any desired time interval, the minimum being approx. 1% of full range.—Electronic Industries

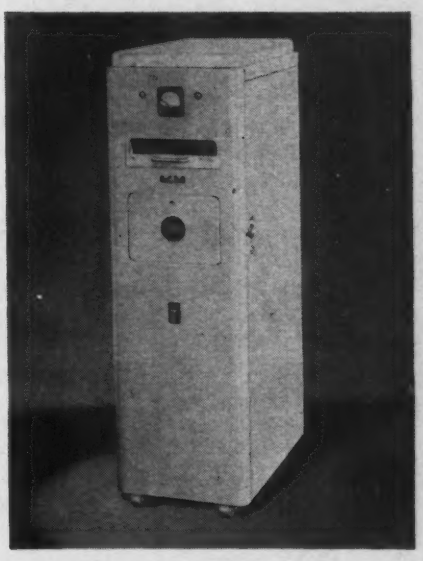


Electronic Precipitator

A 1200 CFM precipitator unit, which is designed to remove 90% or more of all contaminating particles of dust, smoke oil mist, lint or pollen from the air has been developed by the Industrial Electronics Div., Raytheon Mfg. Co., Waltham, Mass. The precipitator is supplied complete with ¼ h. p. motor blower, power pack and collector cell for operation on 115 volts, 60 cycle ac. Power consumption is 50 watts.—Electronic Industries

Variable Transformers

General Radio Co., Cambridge 39, Mass., has developed the V-5 series of Variac autotransformers designed to replace the type 200-C. The new series has been reduced in weight and uses a unit brush, which may be changed without tools. The 115 volt models are rated at 5 amps with a max. current of 7.5. The power rating is .862 KVA.—Electronic Industries



Portable HF Heater

A portable high frequency dielectric heating unit, model 18XO, for the plastics molding industry is in production at Thermex Div., Girdler Corp., Louisville, Ky. The unit has an output of 1 kw and will raise the temperature of approx. 1 lb of general purpose material 170° F in one minute.

Positioning Equipment

DC positioning and indicating equipment to be operated from the ac or dc line is being manufactured by Allis-Chalmers, Milwaukee, Wis. The equipment, which consists of receivers and transmitters, has wide applications in oil fields, steel mills, steam and hydroelectric plants, etc. The relative strength of the magnetic fields of the stator determines the position that the permanent magnet rotor of the receiver will assume.

ELEMENTS OF A NEW O

By **ELMER C. SIMMONS**
Browning Laboratories, Inc., Winchester, Mass.

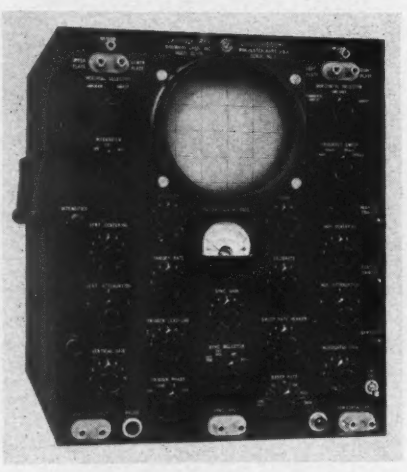
Recent circuits derived from radar research are combined in a new cathode-ray instrument for general laboratory use

• During the past several years the cathode ray oscilloscope has become an indispensable tool in electronic research laboratories. It has proven its superiority over conventional indicating devices in routine test applications where it is able to give simultaneous qualitative and quantitative analyses of electrical phenomena. Recent advances in the electronic art, however, have taken place at such a rate that the average oscilloscope has become inadequate for many applications.

The instrument to be described was designed as a universal laboratory oscilloscope of compact and portable design. A wide variety of time bases is provided to permit observation of the many phenomena encountered in the present-day electronic art. A variety of synchronizing arrangements provides great flexibility. A calibration circuit for determination of input signal amplitude is incorporated as well as numerous other features of interest to the engineer having need of an oscilloscope of universal application.

Sawtooth generator

It has become conventional practice in the design of oscilloscopes to use a thyratron tube type of time base generator to provide suitable scanning voltage for the cathode ray tube. This type of sawtooth generator has the advantage of simplicity but suffers from noticeable defects which limit its usefulness and range of application. The upper frequency limit of a gas tube



Panel of the Browning Model OL-15 oscilloscope

oscillator has been found to be in the region of 40 to 50 kc per second. At the higher limits of such an oscillator, the ionization time of the thyratron becomes an appreciable part of the total available time between successive sweeps, with corresponding difficulties in retrace elimination. Difficulty, too, has been experienced at the higher frequencies in obtaining positive synchronization from signals having steep wavefronts or of short duration.

This oscilloscope uses a modification of a multivibrator as a capacitance discharging medium with the charging rate controlled by a constant current pentode. The upper frequency of the generator, in production models, is better than 500 kc per second with a lower limit of 5 cycles per second. A single range of the coarse sweep control covers a frequency spread of better than 10 to 1, which eliminates much of the constant resetting of the sweep range switch when working over a band of frequencies. Provisions are made for synchronization from an external source, or internally from the vertical amplifier, or from the power line frequency. A portion of the sweep voltage is also made available at the front panel for use in frequency modulation work, etc.

Synchronization is positive and noncritical. In fact, it is usually difficult to set the sweep rate controls deliberately to a position between points of locking-in. The sweep frequency will simply jump from one locked position to the next, as the sweep rate control is varied. With synchronization possible at signal-to-sweep ratios up to 20:1, it is possible to display 10

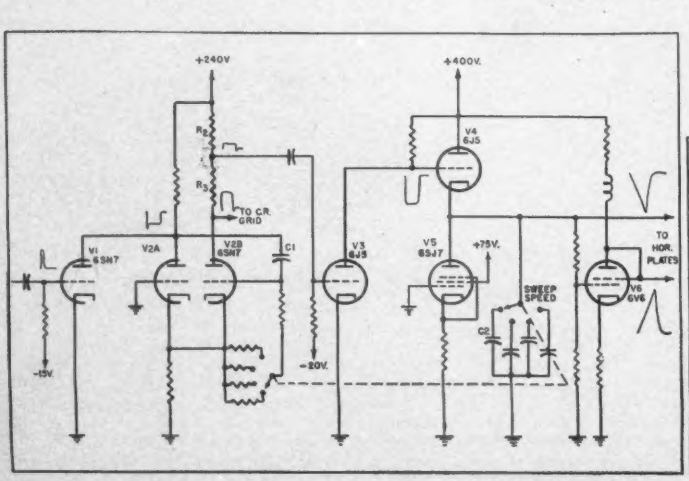
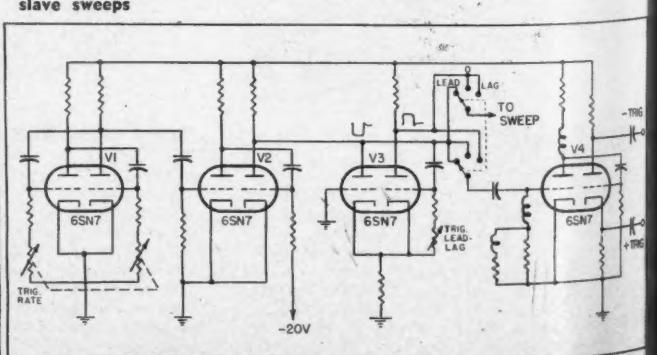


Fig. 1 (left)—Linear time base generator for observing recurrent phenomena

Fig. 2 (below)—Pulse generator for controlling internal or external slave sweeps



OSCILLOSCOPE DESIGN

mc phenomena on the screen so that individual cycles may be examined in detail. On experimental models, frequencies as high as 40 mc per second were viewed with the sweep in synchronism. This feature extends the range of direct waveform observation well into the new television video bands and provides for any increases in band width that are likely to occur in the near future.

Fast sweep

Much of the present investigation in the electronic field is concerned with pulses having a duration of one microsecond or less. Although it is possible to synchronize a sawtooth generator with phenomena of such form, the time duration of such a pulse may be an almost infinitesimal part of the elapsed time between successive pulses. A one microsecond pulse, for example, with a recurrence rate of 200 per second, would occupy one five-thousandth of the time between pulses or, viewed on a 200 cycle sawtooth sweep 4 in. in length, would be less than .001 in. in length. Furthermore, the amount of energy imparted to the screen during the pulse time would be so small that the pulse would be nearly invisible in contrast to the brilliance of the remainder of the sweep. Obviously, such a display would be useless for any sort of analysis of the pulse. The Model 0L-15 oscilloscope has provisions for expanding such pulses horizontally by increasing the speed of that portion of the time base that contains the desired information, while completely eliminating other portions of no immediate interest.

Frequently, it is necessary to work with waveforms of inconstant repetition rates or where successive phenomena may be separated by different time intervals. This oscilloscope provides a sweep separate from the sawtooth generator which operates only upon receiving a triggering impulse. One sweep is produced from each trigger. The initiating impulses may be of either constant or inconstant recurrence rate. Sweeps available are of 5, 20, 100 and 1000 microseconds duration to accommodate a wide range of pulse widths. For operation of the sweep generator, refer to simplified schematic, Fig. 1.

V2B is normally operating with zero bias and develops sufficient cathode-to-ground voltage to reduce the anode current of V2A nearly to zero. A positive impulse applied to the grid of V1 is inverted by V1 and appears as a negative voltage change at its anode and also at the anode of V2A. This is impressed on the grid of V2B through C1, resulting in a decrease in anode current through V2B.

This decrease in anode current results in a drop in the voltage at the cathodes of V2, with a corresponding increase in current through V2A. The voltage at the anode of V2A decreases and continues the process initiated by the positive impulse at the input of V1. Cumulative action results in V2B being rapidly driven to cutoff. The circuit remains in this condition until C1 discharges to the point where V2B begins to conduct once more. Through cumulative action the circuit returns rapidly to its original stable condition.

The positive waveform appearing at the junction of R2 and R3 is inverted by V3, the resulting negative voltage cutting off V4. This allows C2 to discharge through V5 at a constant rate determined by the electrode voltages of V5. The resulting voltage is applied to one deflection plate and through an inverter, V6, to the remaining deflection plate. The use of push-pull deflection results in improved definition of the image.

This circuit is characterized by ease of triggering, linearity of sweep voltage, and constancy of writing rate over wide ranges of repetition rate. The positive pulse at the anode of V2B is applied to the cathode ray tube grid to brighten the screen only during the forward sweep time.

Trigger generator

Many items of electronic equipment have provisions for being externally triggered. In order that the oscilloscope may be used as a synchroscope with such equipment, an internal generator of positive and negative trigger pulses is provided. These are of approximately

(*Continued on page* 118)

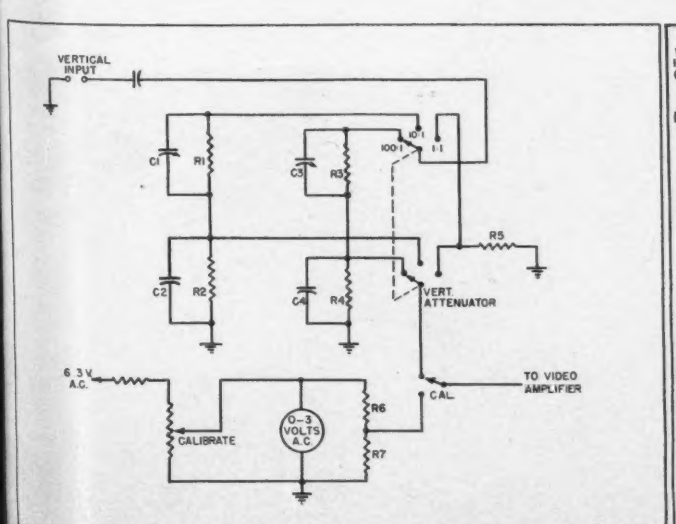


Fig. 3—Vertical input attenuator, showing method of calibrating the video amplifier by substituting a signal of known amplitude

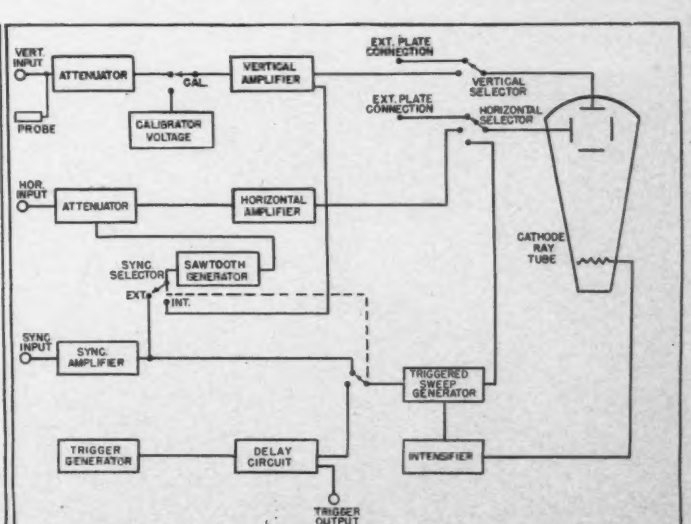
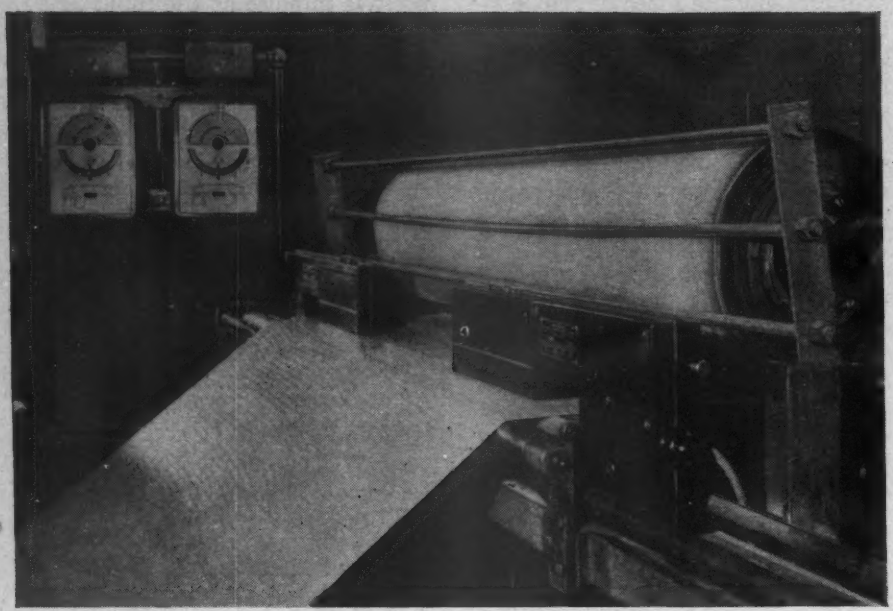


Fig. 4—Block diagram of the complete Model OL-15 oscilloscope. 30 tubes are required, including the type 5LP1 cathode-ray tube

TUBES ON THE JOB



View of calender with dual capacitors for automatic thickness gaging of rubber compounds

Mobile Radio For Trucks

One of the first two-way radio systems for trucks has been inaugurated by the Willet Co. for its trucking operations in the Chicago area. Thus far six trucks have been equipped with two-way radiophones developed by Belmont Radio Corp., Chicago, Div. of Raytheon Mfg. Co. The FM equipment is designed to operate in the 156 to 162 mc band and has proven itself in a variety of uses. A dispatcher may communicate with any truck at any time and place in the normal operating area of the company. He can advise the driver of cancellations and new orders while en route. Drivers use the equipment to report tire trouble, mechanical difficulties or fires and other emergencies.

Rubber Weighing

At Lee Rubber & Tire Corp., Conshohocken, Pa., thickness of rubber compounds impressed upon fabric is accurately measured on the basis of ounces per square yard and recorded by a Verigraph—an instrument developed by Foxboro Co., Foxboro, Mass. Dual capacitors, placed at the take-off end of the calender machine, form part of an oscillator circuit, the frequency of which is changed in accordance with variations in the dielectric of the material passing between the plates. The frequency changes unbalance a measuring circuit and deflect a galvanometer, the pointer of which actuates a clutch arm. This clutch arm rotates a shaft upon which the indicating and recording mechanisms are mounted. A slide wire resistance attached to the same shaft and rotating with it restores the measuring circuit to balance, the amount of restoration being recorded on a chart. The apparatus is set to the correct operating point by means of test samples, zero adjustment being maintained by a standardizing rheostat. The Verigraph eliminates the cutting of numerous samples for hand gaging, thereby permitting closer adherence to material specifications.

Electronic Wheel Balancer

The Alemite Div., Stewart Warner Corp., Chicago, Ill., is marketing an electronic wheel balancer, which represents an important new development for the automotive service industry. By means of this device, designed for one man operation, static and dynamic unbalance may be detected and corrected in less than ten minutes without removing the wheel from the car. A magnetic pickup unit attached to

Two-way radio for trucks operates in the 156 to 162 mc band and uses FM

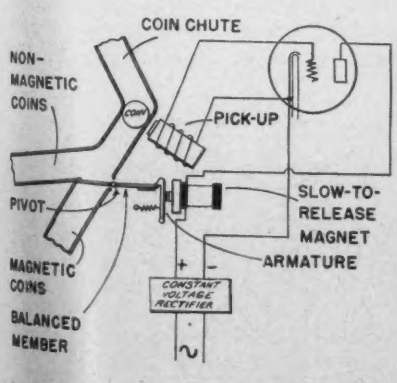
Equipment placed in position for electronic balancing of front wheel

the axle and adjacent to the wheel transmits vibrations resulting from unbalance in the form of current impulses to a meter indicating the degree of unbalance. The pulses from the pickup are also fed to a four-tube amplifier, the output of which actuates a stroboscopic light. Since the stroboscopic flashes are synchronous with the vibrations, the motion of the wheel is apparently "stopped" and the exact spot out of balance is shown. Corrective weights are then placed opposite this spot. The device determines both kinetic unbalance caused by unequal distribution of weight around the center of rotation, and dynamic unbalance produced by uneven weight distribution in relation to the center line of the wheel. Kinetic (static) unbalance results in vertical vibrations. Dynamic unbalance produces vibrations in a lateral plane at right angles to the center line.

For balancing the front wheels, a motor-driven "wheel spinner", provided with the unit, is placed against the tire tread of one wheel. In balancing rear wheels the car's own engine power is used for rotation. Speed is regulated by a remote control. Since the wheels are in their normal operating position, they are balanced as one unit, including tire, tube, hub cap and brake drum.

Electronic Coin Rejector

A very sensitive electronic coin rejector has been invented and patented by William Hatton of the International Standard Electric Corp.



Schematic of electronic coin rejector. Device is sensitive to permeability of coins

The device is responsive to the magnetic characteristics of the coin and may be adapted to either pass or reject coins of high permeability. In the operation of the apparatus the slow-to-release magnet will be operated by the plate current of the vacuum tube which is in turn controlled by a change in flux in the vicinity of the pickup device caused by a high permeability coin. The balanced member will be released and turn on its pivot when struck by the coin which will then drop into the section of the chute marked "magnetic coins."

Thereafter the right-hand lever of the balanced member which is heavier than the left-hand member, will rotate the balanced member back to its original position and the slow-to-release magnet will release its armature, thereby locking the balanced member against rotation. Obviously a low permeability coin will not cause movement of the armature and the balanced member will stay locked so that the coin will slide along it and drop into the chute marked "non-magnetic coins."

Reel Regulator

A new type of electronic drive for wind-up reels has been developed by Westinghouse and was described in an AIEE paper by K. P. Puchlowski. The problem was to maintain winding speed constant regardless of the increase in the diameter of the reel. The job was done by causing the tachometer generator to introduce a correction into the system in such a way that the speed of the motor operating the winding reel is exactly proportioned to the linear speed of the wire as it is wound on. Reel radius increases 2.3 times during the operation.

TACHOMETER TESTING

Five tachometer generators can be tested simultaneously on the testing stand. They are driven by a GE Thy-mo-trol drive, with readings being taken at intervals of 200 rpm

Testing strain gages during preparation for stress measurements on 80 ft. welded trusses

Stress Measurements On Steel Trusses

A total of 144 strain gages were used in recent tests conducted by the Austin Co., Cleveland, to determine and analyze the flow of stresses through welded H-section trusses under load. SR-4 strain gages, made by Baldwin Locomotive Works, were attached to joints at both ends of the first diagonal and other important check points on standard 80 ft. trusses to permit strain measurements as small as one-millionth of an inch in a ½ in. length. The gage itself, a tiny loop of copper-nickel wire with a diameter of 1/1000 in., was cemented to the steel surface so that its length would vary in exact relation with strain. The resistance change produced by the stretching of the gage wire was multiplied by electronic amplification to the required amplitude to operate conventional recording devices. Three automatic switching units and three strain recorders developed by the Foxboro Co. were used to record the strain measurements. Each recorder in combination with a switching unit was set up to measure strains at 48 gage points, permitting 144 individual strain readings to be recorded in about two minutes. Approximately 3000 strain measurements were obtained during various phases of loading up to a peak of 254,000 lb., for which the maximum deflection was about 2 in. After removal of the total live load the maximum residual deflection in both trusses was about 1/16 in.

SURVEY of WIDE READING

Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad

Emission from Cesium or Thorium-Coated Tungsten Filaments

Ch. Biguenet (Le Vide, Paris, Jan. & March 1946)

The emissive properties of tungsten filaments coated with a monoatomic layer of either cesium or thorium are reported in great detail. The processes of formation of the monoatomic layer by diffusion from the inside of the wire and by deposition by condensation are explained, as well as the accompanying changes in the work function. Carbonization of coated filaments and its effect on the filament characteristics are investigated.

Magnetically-Controlled Gas Discharge Tubes

R. E. B. Makinson, J. M. Somerville, K. R. Makinson and P. Thonemann, U. of Sydney, Australia (J. of Applied Physics, July 1946)

The discharge between the cathode and anode of a gas or vapor filled tube, initiated by the sudden application of a magnetic field, was studied with the object to use this type tube as pulse modulators for magnetrons in radar equipment. A satisfactory tube was developed having two coaxial cylindrical electrodes, together with a mercury pool as an auxiliary cathode, see Fig. 1. A glow discharge in the mercury vapor between the cylinders was initiated by a magnetic field pulse, and bombardment of the pool by ions from this glow discharge produced an arc spot on the pool through which the main current passed. These tubes passed current up to 200 amperes in 2-megawatt pulses of duration 1 to 10 microseconds at repetition frequencies up to 1200 cycles per second with very small power loss in the tube itself.

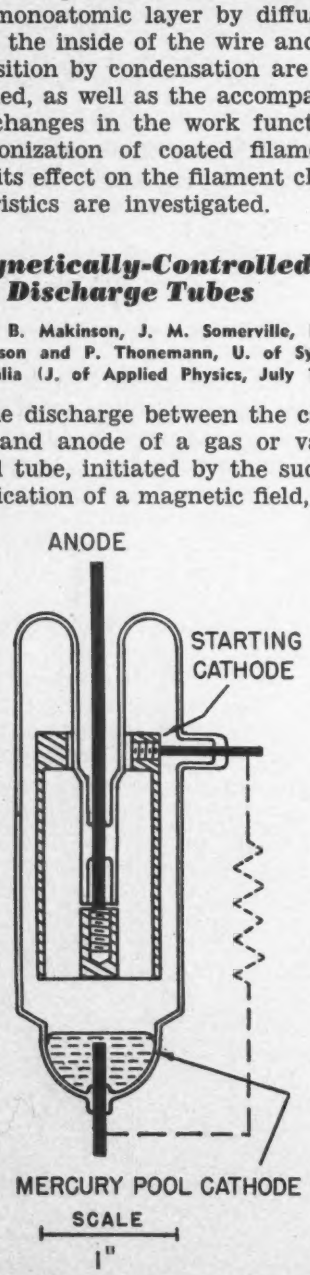


Fig. 1—Magnetically controlled mercury tube

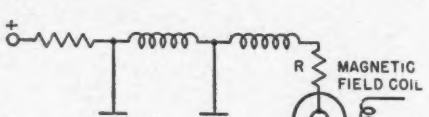


Fig. 2—Circuit used for testing discharge tube

Performance of the tube was studied in a circuit as illustrated in Fig. 2, which approximated that in which they would be required to operate as radar modulators, where the resistive load R corresponds to the radar oscillator. A magnetic field pulse of peak intensity 350 oersted was sufficient to fire the tube.

Emission from Tungsten Oxide Films

F. Llewellyn Jones (Nature, London, March 23, 1946)

The occurrence of cold cathode emission in a gas from metal surfaces covered with a thin oxide layer or dust opened up the possibility of devising a self-triggering, two-electrode spark gap. With this object experiments were carried out on the electrical properties of tungsten electrodes on which were formed films of oxides of tungsten.

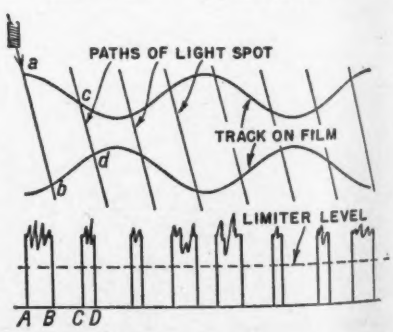
The most effective oxide with regard to electron emission appeared to be a mixture of the yellow and blue oxides, which together appeared as a white deposit. Further, a polarity effect was found when an oxidized electrode was used in conjunction with clean, smooth tungsten as the other electrode. However, this polarity effect seems not to apply if rough electrodes instead of oxides are used to increase emission, indicating that the mechanism of emission is different for oxidized and for roughened electrodes.

Reproducing Sound Film

W. K. Westmijze (Philips Technical Review, April 1946)

To eliminate noise from specks of dust or scratches on the sound track of sound films, a flying spot scanning method has been developed where only the edges of the track determine the output which is independent of any variations in the transparency inside the track.

A series of light spots move at a high velocity and at regular intervals across the film (see top figure). The photocell will generate approximately rectangular current pulses, as shown in bottom of figure, the intensity of which depends on the light intensity and the duration of which is a function of the width of the track. Variations of the transparency inside the track produce amplitude variations which are eliminated by a subsequent limiter as is indicated by the dashed line in the drawing.



Top—Sound film with light-spot path. Bottom—Photocell output illustrating relations between width of sound track and width of pulses

For conversion of these high fre-

quency pulses into the desired audio signal, the pulses are passed through a low-pass filter which averages over successive blocks for a time interval approximately one quarter of the duration of the highest audio frequency. The result is a strong signal when the square waves are wide and a weak signal when they are narrow as is desired.

The scanning frequency of the light spot must be at least five times the highest audio frequency to be transmitted to assure satisfactory reproduction of sound. It is proposed to use a scanning light spot of 100 micron length (direction of spot movement) and 20 micron width (direction of film movement)

Removing Wire Insulation

E. J. Flynn and G. W. Young (General Electric Review, June 1946)

Various chemical methods to remove the insulating film from Formex wire have been investigated and compared as to speed, cost, convenience and safety of handling. Solvents, liquid strippers, acids, alkalis, acid pastes, fused salts, and glass bonding and cracking, resin solvent combinations, removal by flame and immersion in molten solder are discussed. Some of the chemicals which may be used can be dangerous, hence the advice of a chemist is desirable. The table lists only a few of the many possibilities studied and reported in some detail in the article. The dip intervals stated refer to 0.008 in. Formex wire.

Some preparations are used at room temperatures:

Liquid Strippers (20 sec. dip)

1. 18 ammonium hydroxide
   27 phenol
   43 dichloromethane
   8 beeswax
   4 ammonium laurate

Two-Phase Systems (either requires 45 sec. dip)

2. 2 parts formic acid (Bottom Liquid)
   1 part kerosene (Top Liquid)
3. 2 parts formic acid (Bottom Liquid)
   1 part E.W. naphtha (Top Liquid)

Acid Pastes

4. Nitric acid (15 sec. dip)
5. Formic acid (1 min. dip)

Other compounds are used in molten state, such as:

6. 51% hydroxide
   49% potassium hydroxide
   (5 sec. at 275°C. or 2 sec. at 300°C.)
7. 50% potassium hydroxide
   50% potassium nitrite
   (5 sec. at 300°C.)
8. 63% potassium iodide
   37% potassium hydroxide
   (2 sec. at 400°C.)
9. Sodium hydroxide (0.2 sec. at 550°C.)
10. Potassium hydroxide (0.2 sec. at 400°C.)
11. 40% sodium iodide
    60% potassium iodide
    (0.2 sec. at 600°C.)
12. Potassium iodide (0.2 sec. at 710°C.)

Aerial Prospecting

(Bell Laboratories Record, July 1946)

An aerial prospecting device for potential oil and mineral-producing areas has been developed as an outgrowth of a hitherto secret magnetic submarine locator. It draws a continuous record of the magnetic properties of the terrain over which it is flown, indicative of possible locations of natural resources. The device may prove particularly valuable in inaccessible areas as polar regions, jungles and offshore tidewaters, permitting a rapid, large-scale survey of geological structures in these territories. Some 40,000 square miles in this country and Alaska have already been mapped.

Powdered Iron Cores

C. T. Martowics (Steel, April 1, 1946)

Composition, manufacturing process and characteristics of various types powdered iron cores suitable for high frequency electronic applications are discussed.

Non-Linear Bridge Circuits as Voltage Stabilizers

G. N. Patchett (Journal of the Institution of Electrical Engineers, London, Part III, January 1946)

The paper deals with the theory and design of voltage stabilizers where a Wheatstone bridge, Fig. 1, incorporating one or several non-

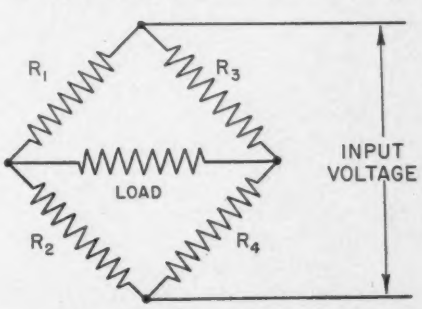


Fig. 1—Diagram indicating arrangement of non-linear resistors in voltage-stabilizing bridge

linear resistors, provides a compensating voltage which is proportional to the change in the input voltage. Four types of resistor combinations studied are listed in table below. In Fig. 2 is shown the general shape of the output voltage-input voltage relationship of a non-linear bridge circuit; for the present purpose, the circuit constants are adjusted for the bridge to operate at the point "Q".

Detailed information concerning the design of various types circuits and the effects and importance of the various circuit elements is presented. Factors determining the figure of merit (the ratio of the change in output voltage with a change in input voltage) at the

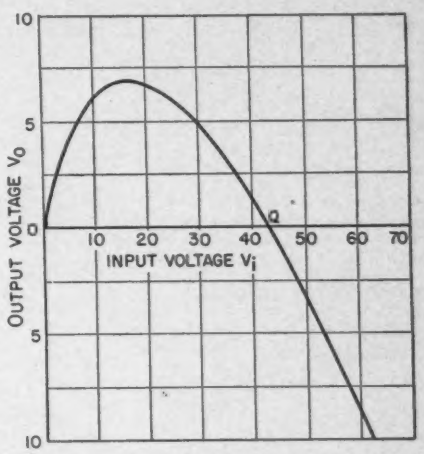


Fig. 2—General shape of output-input voltage relation of a non-linear Wheatstone bridge

point "Q", which should be as large as possible, are considered. Formulas are given for the load required for maximum power output from the bridge for a given change in input voltage.

The non-linear elements which may be used in these circuits have to obey the law: $V = kI^n$. Tungsten and carbon filament lamps, ballast resistors, Thyrites, copper and selenium rectifiers and thermistors obey this law over at least a portion of their characteristics. An extensive table and several charts facilitate design of non-linear voltage stabilizer bridge circuits.

Electronic Governor

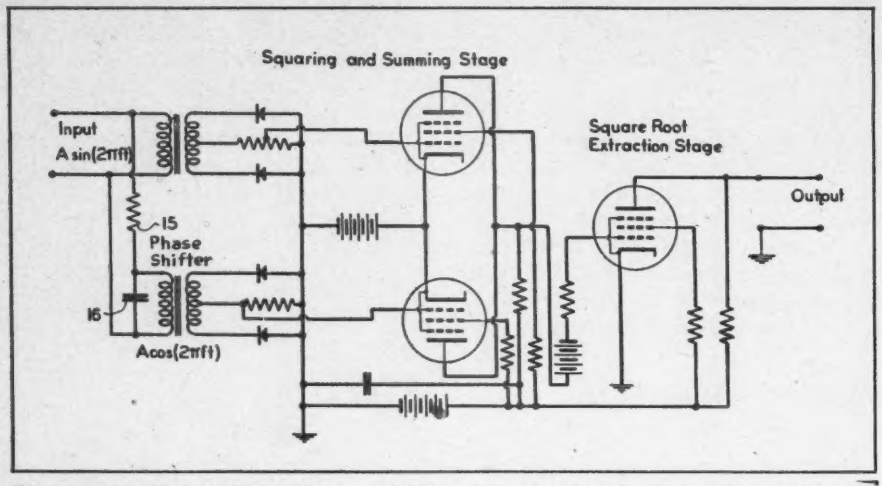
G. Newstead (Electrical Engineer and Merchandiser, Melbourne, Australia, February 15, 1946)

The general operational features of electronic devices, called electronic governors, intended for the frequency control of alternators, are explained.

(*Continued on page* 136)

Type	R_1	R_2	R_3	R_4	
1	linear	linear	$V = kI^n$	linear	n arbitrary
2	"	"	$V = kI^n$	$V = k''I^m$	$n>1, m<1$
3	"	$V = k'I^n$	$V = kI^n$	linear	n arbitrary
4	$V = k''I^m$	$V = k'I^n$	$V = kI^n$	$V = k''I^m$	$n>1, m<1$

NEW PATENTS ISSUED



Circuit capable of detecting amplitude modulation if signal and carrier frequencies are very close

Detector

The detector is capable of separating the modulation envelope from a carrier frequency although the modulation frequency and the carrier frequency may be relatively close together. Further no filter is required.

The input wave A sin $(2\pi ft)$ is applied to a phase shifter 15, 16, introducing a 90 deg. phase shift and providing a wave A cos$(2\pi ft)$. Both signals are passed through squaring devices (full-wave rectifier and tube combination), the outputs of which are added to obtain a wave of the shape: $A^2\sin^2(2\pi ft)+A^2\cos^2(2\pi ft)=A^2$. A square root extraction stage supplies the desired output. In the drawing a particular circuit operating on the principle claimed is represented.

H. Harris, Jr., Sperry Gyroscope Co., Inc. (F) February 1, 1943, (I) April 9, 1946, No. 2,397,961.

Magnetostrictive Radar Clock

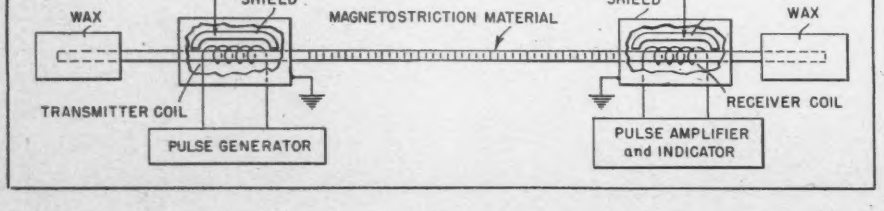
The exact measurement of short time intervals of the order of 10 to 1000 microseconds, essential in radar systems, may be performed with considerable accuracy by a simple magnetostrictive arrangement.

The short pulse, marking the beginning of the time interval to be determined, is applied to the transmitter coil, see figure, and causes expansion or contraction of the magnetostrictive material. Receiver coil picks up the wave and the received pulse is amplified and applied to an oscilloscope. The two wax blocks supporting the magnetostrictive rod act as dampers absorbing the sound wave at both ends so that no reflections take place. The two permanent magnets maintain the magnetostrictive rod magnetized a sufficient amount to secure good magnetostrictive conversion properties.

As the speed of travel of the magnetostrictive wave is equal to the sound wave for the particular material, the sound velocity times the traveling time is equal to the distance between transmitting and receiving coils. If the sound velocity is known, the rod may be calibrated in units of distance or time as desired. Either the sending or the receiving coil and accessories are mounted slidably on the rod so that the received pulse may be made to occur simultaneously with, for instance, the reflected radar pulse. Twice the distance of the object under observation by the radar unit will then be equal to the distance between the two coils multiplied by the ratio radar wave velocity to sound wave velocity.

M. G. Nicholson, Jr., Colonial Radio Corp., (F) June 23, 1944, (I) May 28, 1946, No. 2,401,094.

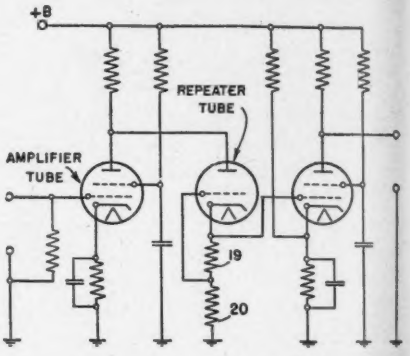
Magnetrostrictive wave propagation arrangement accurately measures very short time intervals



Direct Coupled Amplifier

In the present dc multi-stage amplifier successive stages are not operated at progressively higher potentials and the overall amplification of each stage is substantially linear, distortionless and quiet.

Each stage consists of an amplifier tube; the plate of which is directly connected to the plate of a repeater tube which is coupled as a cathode follower. Since resistor 19 is not by-passed, the repeater tube will have a non-linear characteristic, its resistance being a function of the voltage developed across resistor 19. Non-linearity in the mutual-conductance characteristic of the amplifier tube can readily be compensated for by a proper selection of the values of resistors 19 and 20. It will be appreciated that the output of the first stage, consisting of amplifier and repeater, is not at a high positive potential as in conventional dc amplifier. Any desired number of amplifier stages may be connected in cascade.



J. R. Beckwith, Belmont Radio Corp., (F) June 12, 1944, (I) May 21, 1946, No. 2,400,734.

Pulse Generator

It is proposed to generate pulses which are determined by the near zero portions, instead of the peaks of a sine wave. Shorter better defined pulses at constant comparatively long intervals may be obtained because of the steeper slope of the voltage-time curve at these points.

Audio amplifier tubes 5 and 7

(*Continued on page* 139)

A NEW ECONOMICAL RESISTOR LINE

PERMANENT LOW UNIT COST

CLOSE TOLERANCE LIMITS

PROMPT DELIVERY

QUALITY

IN-RES-CO

TYPE ALA — 3 WATTS
MAX RES: 25,000 Ohms (Nichrome)
MAX. RES: 5,000 Ohms (Manganin)
BODY SIZE: 1⅛" Lg. by ⅜" Dia.
MOUNTING: By Axial Leads
TERMINALS: No. 18 Tinned Copper Leads, 2 Inches Long
TOLERANCES: Standard 3% (1% at Slight Extra Cost)

TYPE ACA — 6 WATTS
Same as Type ALA except coated with high temperature cement.

TYPE BLA — 5 WATTS
MAX. RES: 50,000 Ohms (Nichrome)
MAX. RES: 10,000 Ohms (Manganin)
BODY SIZE: 1⅝" Lg. by ⅜" Dia.
MOUNTING: By Axial Leads
TERMINALS: No. 18 Tinned Copper Leads, 2 Inches Long
TOLERANCES: Standard 3% (1% at Slight Extra Cost)

TYPE BCA — 10 WATTS
Same as Type BLA except coated with high temperature cement.

Types ALA, ACA, BLA, BCA can be supplied with non-inductive winding with 50% reduction in maximum resistance. Add suffix "N" to code when specifying non-inductive types (ALAN, ACAN, BLAN, BCAN).

Dependable!

This new line of resistors—designed to meet current demands for small, low-cost, quality units of close tolerance—is immediately available. They cover the full range from 1 watt to 10 watts and 1 ohm to 1 megohm. Designed for long life and stability, these components have hard soldered connections between resistance wire and terminals, assuring permanent noiseless, trouble-free units. These new resistors are engineered for the manufacturer who desires to retain a reputation of top quality and performance in his equipment. Like all IN-RES-CO products they are produced under rigid control by modern facilities. Write for details.

TYPE BX — 1 WATT
NON-INDUCTIVE

MAX. RES: 1 Megohm (Nichrome)
MAX. RES: 30,000 Ohms (Manganin)
BODY SIZE: 1-5/16" Lg. by 9/16" Dia.
TOLERANCES: Standard 3%
(To 1/10% at Slight Extra Cost)

TYPE CX - 1 WATT
NON-INDUCTIVE

MAX. RES: 500,000 Ohms (Nichrome)
MAX. RES: 15,000 Ohms (Manganin)
BODY SIZE: ¾" Lg. by 9/16" Dia.
TOLERANCES: Standard 3%
(To 1/10% at Slight Extra Cost)

INSTRUMENT RESISTORS CO.
29 AMITY STREET, LITTLE FALLS, NEW JERSEY

WASHINGTON

Latest Electronic News Developments Summarized by *Electronic Industries'* Washington Bureau

PRICE CLOUDS SOON TO CLEAR—Decontrol of prices of home receivers and parts was goal, anticipated to be achieved by radio manufacturing industry this fall, as a result of the conference between the Radio Manufacturers Association leadership and chief aides of OPA Administrator Paul Porter early last month. Presentations of the industry's viewpoint that freedom from price regulation and full production were the answer to achieve fair prices for the public were made to the OPA top officials and the new Decontrol Board. Some relief came after initial conference in reduction of discount absorption by manufacturers for medium and high-priced sets so retail prices rose an estimated 4%. Manufacturers were "on the mark" for sharp increase in set production this fall, especially in consoles and combinations. August production better than equalled July output which had been somewhat higher than June's figures of 1,378,000 sets which was better by over 200,000 than the prewar production.

CONGRESSIONAL PROBE OF FCC—If Republicans gain control of Congress next session, FCC seems certain to be placed on investigation griddle. Aimed at handling of FM broadcasting and including repercussions on the "upper band" FM controversy was the resolution of Senator Tobey, New Hampshire Republican, friend of FM broadcasting leaders and intensely interested in that field's development. Resolution was introduced too late in session for consideration, but is certain to be rivived in new Congress. On House side, several Republicans have their axes out for FCC. Wigglesworth of Massachusetts long has criticized broadcasting regulation processes, while Lemke of South Dakota wants farms to have more FM stations. FCC is striving this summer and fall to clear away its decks to avoid any Capitol Hill storm. (See following items.)

TELEVISION DECADE MARK—Ten years ago last month (August) the FCC conducted its first engineering conference on television frequencies and standards. Of course, the war period interfered with the birth of this industry, although the speeded-up research of the war era will soon bear fruits in a large way and the problems of reconversion, together with the controversy over black-and-white and color video, have slowed up the establishment of stations on the ether. Television has been marking more time recently with regard to FCC actions than the other broadcasting services, but indications are for a substantial number of new TV stations to start operations this fall. FCC would speed Tele. In August the FCC count for television was six stations on the air; 24 construction permits granted with several stations, like NBC and Bamberger in Washington, ready to start telecasting soon; and 54 station applications pending. The FCC is anxious that TV station operators with already authorized construction permits not "sit on" their channel assignments but start video broadcasting at the earliest date possible. Impetus to television's progress, however, expected to be given by determinations by Radio Technical Planning Board's TV Panel this fall on UHF color engineering standards.

BROADCASTING SERVICES ON MARCH—Washington heat and work do not mix, but the FCC in order to launch broadcasting on its postwar expansion has kept its nose to the grindstone during the entire summer. Statistics of applications with the Commission, already authorized or pending action, tell the story of the outlook of growth in the radio broadcasting fields. AM-standard broadcasting is far from saturated, the FCC figures show—there are 965 stations now on the air; around 300 licenses and construction permits have been granted so far this year; another 300 in the hearing stage; and about 350 applications being processed.

FM BROADCASTING SHIP NOW SEEMS LAUNCHED—Spurred on by the threats of a Congressional investigation, FCC is concentrating efforts to clear its decks of station applications. The box score stood at the end of August, according to Commission estimates: over 250 stations on the air or under construction; more than 500 conditional grants; and approximately 300 applications in hearing or pending for processing. In tune with this heightened tempo of FCC grants of FM stations is the radio manufacturing industry in the output of FM receivers. Zenith, Stromberg-Carlson, Philco, Freed, General Electric were reported during August to be producing AM-FM combination receivers at the rate of over 10,000 sets a week for each company.

PATENT OFFICE BACKLOG—Huge backlog of patent applications awaiting action by Patent Office, which has risen 81% in past year, is felt to be bad bottleneck in reconversion. Greatest number of pending cases is radio-electronic industry which falls under Patent Office's "radiant energy" division and nonprocessed inventions estimated at over 3500 applications. Division of Patent Office force between Washington and Richmond, Va., is felt major factor in backlog status.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

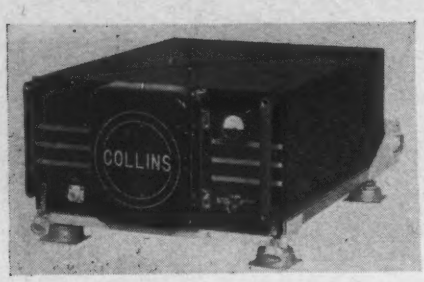
GUARDIAN relays *for every control need*

In precision control of today's products you will usually find *standard* type Guardian Relays. Such recognition of *standard* type Guardian Relays by forward thinking design engineers is the result of forward planning by Guardian to produce basic design relays with the highest potential of variations. Thus, in many cases where "specials" were formerly deemed necessary, variations of Guardian's *standard* type relays proved better qualified on *performance—price—delivery*. Guardian controls include a complete line of basic type relays—solenoids—magnetic contactors—switches. If a "special" unit or a complete control assembly is needed, Guardian's expert engineering is at your command. Write for bulletin No. T R-9.

GUARDIAN ELECTRIC
1622-K W. WALNUT STREET CHICAGO 12, ILLINOIS

ELECTRONIC PRODUCTS

Parts, components, materials the manufacturers offer

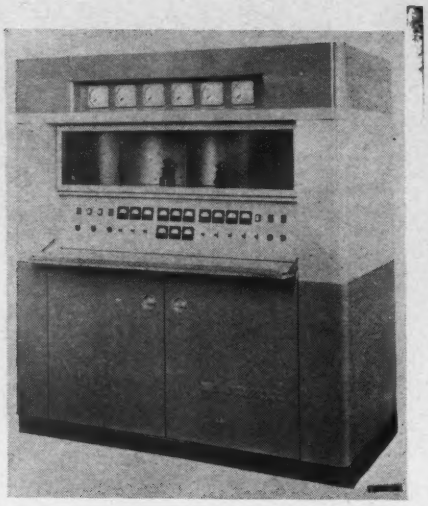


Aircraft Radio Equipment

An aircraft transmitter-receiver type 18S-1 provided with pretuned circuits and ten operating channels with two frequencies each has been developed by Collins Radio Co., Cedar Rapids, Iowa. Covering a frequency range from 2 to 10 mc, the transmitter supplies a power output of 100 watts into a 50 ohm transmission line. The receiver is controlled by a separate group of crystals and operates directly from a 26.5 volt dc source. It is equipped with dual output, automatic noise limiter, avc and one stage of trf amplification. Total weight of the equipment is 60 lbs. Type 180K-1 antenna loading unit is available as a companion unit for the combination.—Electronic Industries

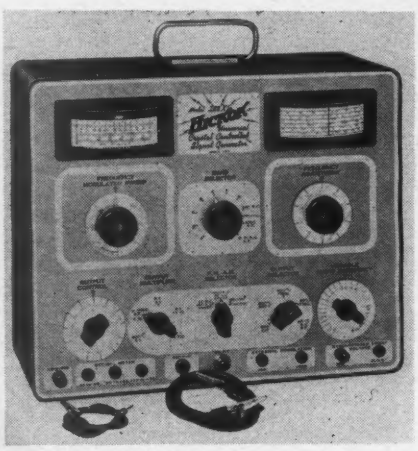
Dielectric Heater

A dielectric heater for plastic preforms, designed for operation at 40 mc, is in production at General Electric Co., Schenectady, N. Y. A water-cooled tube with high overload capacity makes possible use of an average 5 KW output during the entire heating cycle, thus speeding up the preheating operation. A push-button starts the preheating cycle, which is fully automatic thereafter.—Electronic Industries



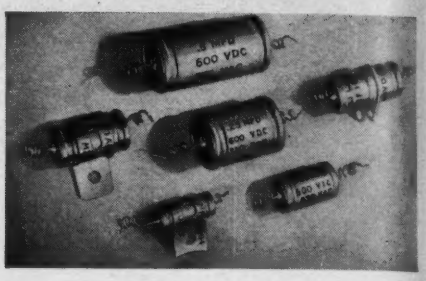
FM Transmitter

New 1- and 3-kw FM transmitters, which maintain close frequency control without use of critically-tuned elements and moving parts, have been developed by Westinghouse Electric Corp., Pittsburgh 30, Pa. The transmitter utilizes standard commercial type tubes in a simple FM circuit containing capacitors, resistors and non-microphonic diode tubes. The rf carrier is generated, multiplied and amplified in 5 steps and a single control adjusts the MO tuning frequency.—Electronic Industries



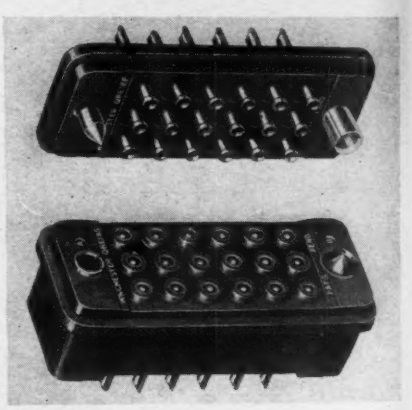
Wide Range Signal Generator

Model 288X crystal controlled signal generator has been redesigned by Hickok Electrical Instrument Co., 10528 Dupont Ave., Cleveland 8, Ohio, to meet present requirements of FM and television receiver testing. Internal crystals enable frequencies to be checked to 0.01% at intervals of 100 or 1000 kc. The output can be frequency modulated over the entire 0.1 to 160 mc range at deviations of ±30, 150 or 450 kc from an internal 60 or 400 cycle source or an external audio oscillator up to 15,000 c/s.; 400 cycle or external amplitude modulation is also available up to carrier frequencies of 110 mc. A self-contained output meter is calibrated from —10 to +38 db and 0 to 140 rms volts and a 0-15,000 c/s audio oscillator is also incorporated. For visual alignment work, a properly phased 60 cycle voltage is provided for synchronizing the oscilloscope sweep.—Electronic Industries



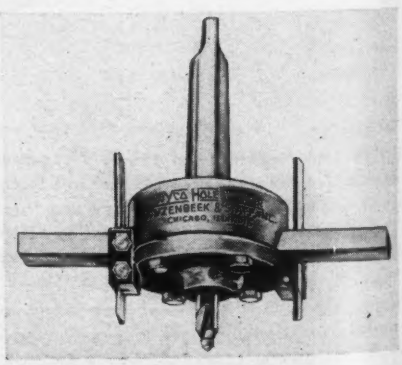
Feed-Through Capacitors

Hermetically - sealed, metal - cased, feed-through capacitors suitable for communications equipment, by-pass, coupling and filtering purposes are in production at Cornell-Dubilier Electric Corp., South Plainfield, N. J. The capacitors range from .01 to .5 mfd and are rated at 600 v dc and 330 v ac, both at 15 amps. The units have low power factor and are not affected by temperatures as high as 85° C.—Electronic Industries



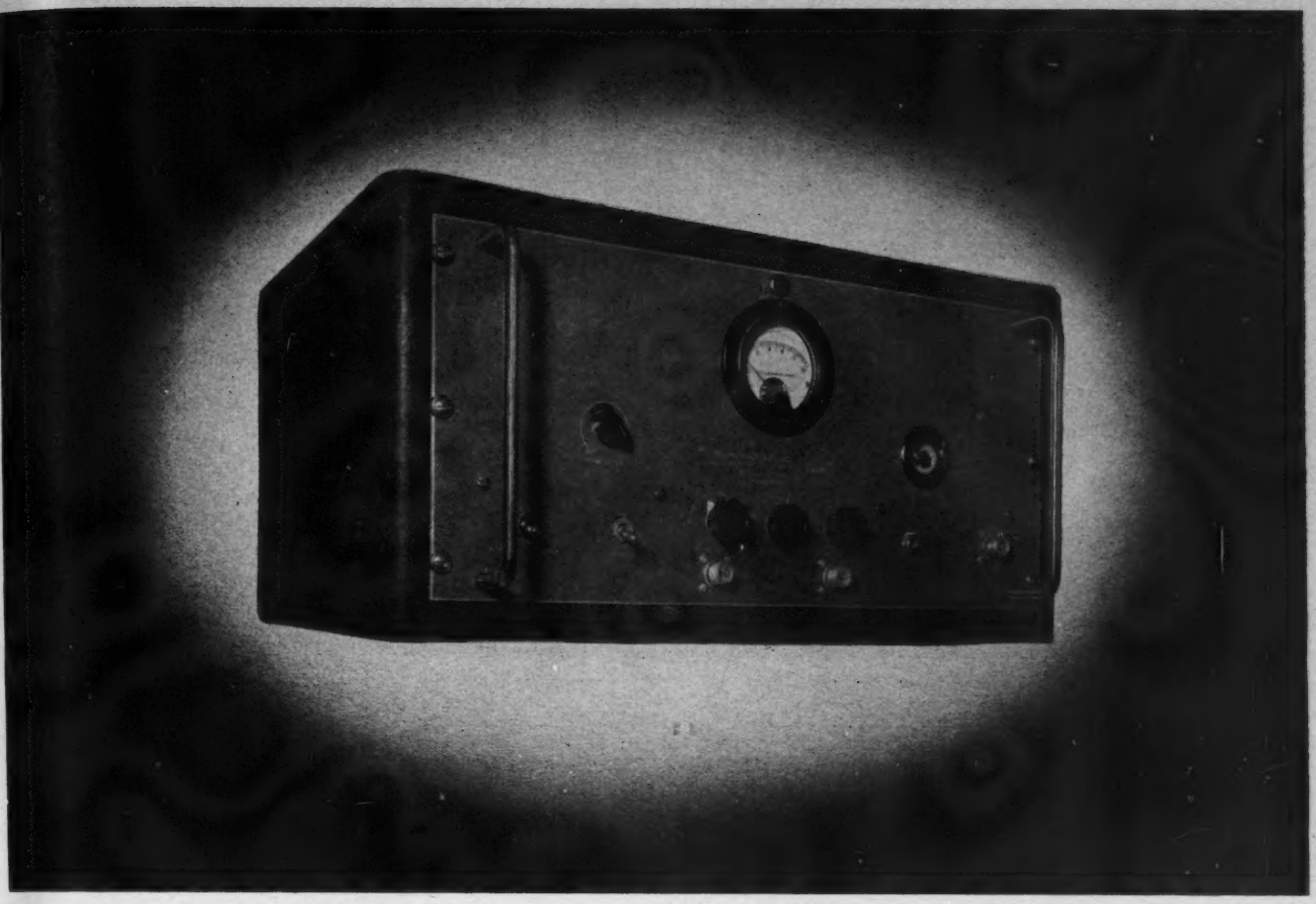
Multiple Connector

A multiple contact connector molded of Melamine plastic is available from Winchester Co., 6 E. 46th St., New York 17. Monoblock type construction permits easy removal of contacts. They can be supplied in two sizes—with 12 or with 18 contacts. —Electronic Industries



Hole and Washer Cutter

A heavy duty hole and washer cutter, which may be used on steel plate and other materials up to ½ in. thickness is in production at Wyzenbeek and Staff, 838 W. Hubbard St., Chicago 22, Ill. The cutter fits on a 1 in. drill chuck and is adjustable from 4½ to 10 in. diameter.—Electronic Industries



LAVOIE C-200

Harmonic Frequency Generator

Now you can obtain precision calibration up to and beyond 2000 megacycles of receivers and wavemeters at a fraction of the time previously required. Also, by means of a Beat Detector built into the instrument, you can calibrate oscillators and signal generators with equal ease.

The C-200 Harmonic Frequency Generator is a secondary frequency standard, designed especially for calibration work above 100 MC, with an accuracy of .02%. If greater accuracy is desired, the crystal may be supplied with temperature control.

The output voltage is supplied at a UG 58/U, 50 ohm connector with output coupling controls to obtain peak performance for a given harmonic. A milliammeter is incorporated in the instrument to facilitate easy adjustment of the output controls. The output voltage may be either unmodulated, or modulated with 400 C.P.S. internal oscillator. The calibrator provides output voltages every 10 MC, or every 40 MC. This selection is made by a switch on the front panel. The harmonic voltage is in the order of thousands of microvolts for each harmonic with a value of approximately 50,000 microvolts at 100 MC's and 1500 microvolts at 1000 MC's.

Provision is made for the calibration of signal generators and oscillators by the incorporation of a beat frequency detector in the calibrator. The output of this beat frequency detector may be monitored, either aurally or visually with a tuning eye indicator.

To facilitate harmonic identification, frequency identifiers can be supplied for any harmonic frequency (multiple of 10 MC) between 100 and 1000 MC. The identifier is adjusted at our factory.

The C-200 Harmonic Frequency Generator can be used to calibrate signal generators, receivers, transmitters, wavemeters and oscillators. It provides a fast, accurate and easy method of calibrating in 10 or 40 MC steps.

This instrument is supplied with accessories needed for its operation, including tubes, 5 MC crystal, output coupling cable and instruction book.

U H F

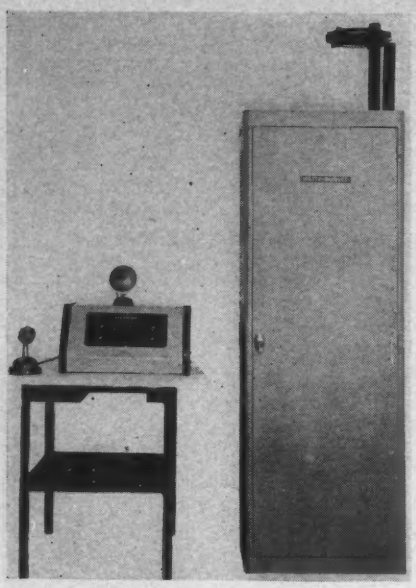
Write for Illustrated Descriptive Folder

Lavoie Laboratories

RADIO ENGINEERS AND MANUFACTURERS

MORGANVILLE, N. J.

Specialists in the Development and Manufacture of UHF Equipment

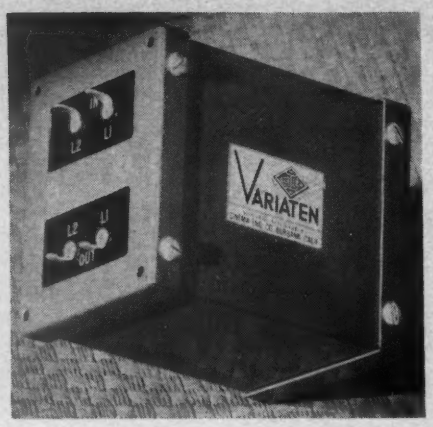


FM Railroad Equipment

Railroad radio equipment consisting of fixed station and mobile assemblies for operation on 117 volts ac is in production at Westinghouse Electric Corp., Pittsburgh 30, Pa. Rotary converters are provided with the mobile units for a 32 or 64 volt dc supply. A crystal controlled oscillator followed by frequency multipliers comprise the fm transmitter, which operates in the 152-162 mc band.—Electronic Industries

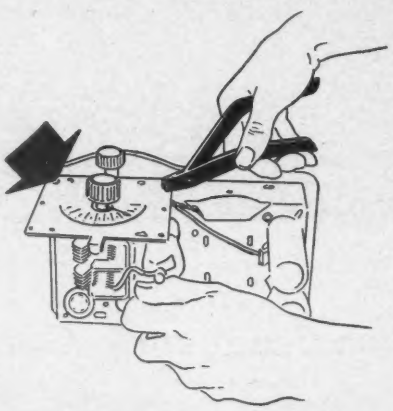
Direction Finder

A dual remote control automatic radio direction finder for aircraft is in production at Fairchild Camera and Instrument Corp., Jamaica, N. Y. The 16-tube receiver operates directly from the 28 volt power supply and covers a continuous frequency range from 100 to 1750 kc in four bands. The instrument has a normal antenna sensitivity of 5 microvolts and a loop sensitivity of 25 microvolts per meter. Bearing accuracy is within 1° for nominal field strength. The unit is designed to withstand high altitude effects, tropical deterioration and high humidity.—Electronic Industries



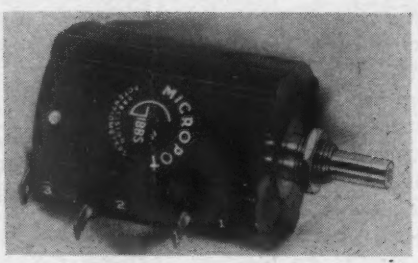
Equalizer

An orthocoustic equalizer to compensate for high frequency losses in 500 and 600 ohm circuits is available from Cinema Engineering Co., 1510 W. Verdugo Ave., Burbank, Cal. The equalizer provides hf accentuation of approx. 16 db at 10 kc and has an insertion loss of 16 db.—Electronic Industries



Rivet "Gun"

A light-duty blind rivet gun for small fastening jobs which installs the rivet with a simple pull has been brought out by Cherry Rivet Co., 231 Winston St., Los Angeles 13, Cal. The one-hand plier-like tool installs a 3/32 in. diameter Cherry blind rivet of the pull-through, hollow type.—Electronic Industries

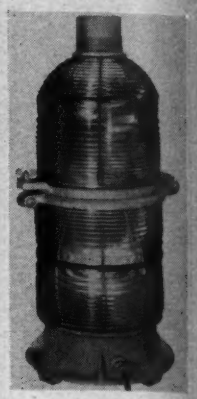


Precision Potentiometer

Developed for wartime applications requiring accurate and permanently calibrated precision controls, the "Micropot", manufactured by Thomas B. Gibbs & Co., Delevan, Wis., provides a linearity of resistance vs rotation of 0.1%. This degree of accuracy is due to the 43½-in. long, spiral wound resistance core which is molded into a bakelite case having a diameter of only 1¾ in. and a length of 2⅛ in. The shaft requires 3,600° (10 turns) of rotation to traverse the full range of resistance, which may be any of several available values from 500 to 30,000 ohms.—Electronic Industries

Railroad Antenna

An antenna for two-way communication between train and fixed station working on the 160 mc band has been brought out by American Phenolic Corp., Chicago 50, Ill. The antenna uses the metal top of the car for its ground plane and has a voltage standing wave ratio of less than 1.5 to 1. The gain is 0.5 decible less than a dipole.—Electronic Industries (Below, left)



Code Beacon

A 300 MM code beacon complying with CAA requirements for lighting radio towers of 150 ft. and higher has been brought out by Andrew Co., Chicago 19. The light of two 500 watt prefocus lamps is passed through red pyrex glass filters and then radiated in a circular horizontal beam by cylindrical fresnel lenses.—Electronic Industries

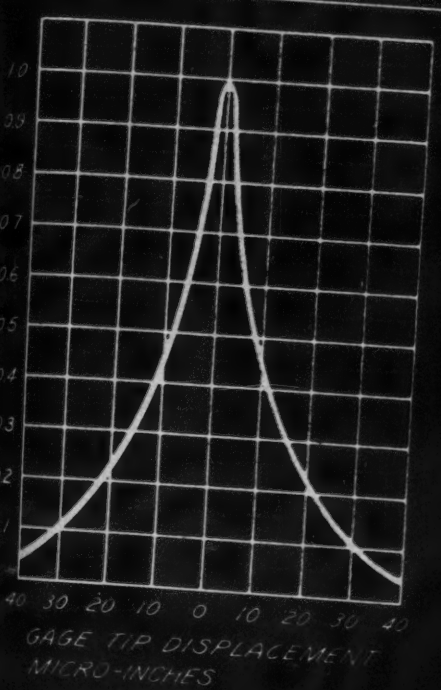
Tubular Capacitors

J. P. O'Donnel and Sons, 316 Stuart St., Boston 16, Mass., has brought out a line of paper tubular capacitors available in ranges from .001 to 1.0 mfd and voltage ratings of 200, 400, 600 and 1000 volts dc.—Electronic Industries

Water Resistant Plastic

A thermoplastic material that will not absorb water, developed by Duorite Plastic Industries (Culver City, Cal.), is a combination of ceramic and resinous ingredients, called "Plastiform". Test specimens have been immersed in water for more than three months at a time without taking on enough moisture to register an increase in weight on a delicate chemist's scale. Plastiform can be reheated and recast innumerable times, like metals, without additives. It has a compressive strength of more than 15,000 lbs. per sq. in.—Electronic Industries

The VIBROTRON

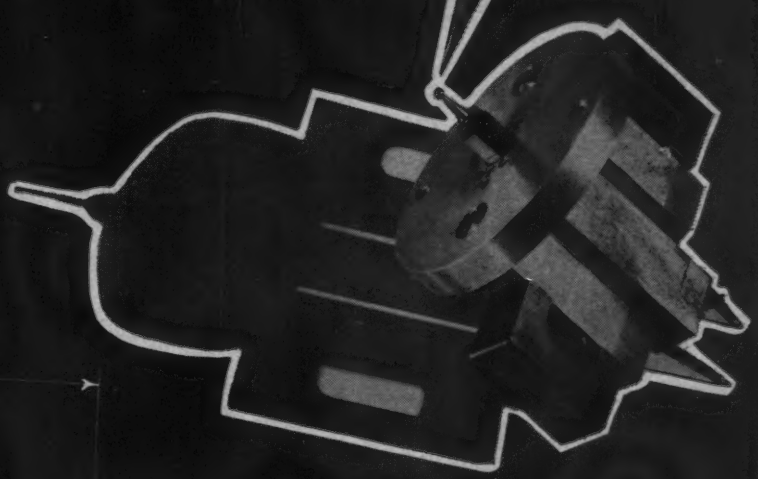


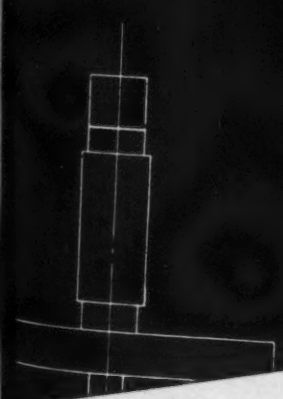
PROBLEM

TO PROVIDE A GAGE FOR SORTING STEEL BEARING BALLS IN ACCORDANCE WITH THEIR DIAMETER.
SENSITIVITY REQUIREMENTS – ACCURATE TO NEAREST MILLIONTH OF AN INCH.
ACCURACY TO BE UNAFFECTED BY MODERATE TEMPERATURE CHANGES
OPERATION TO BE UNAFFECTED BY LINE VOLTAGE CHANGES
ONCE SET, TO REMAIN STABLE WITHOUT CALIBRATION

SOLUTION

(a) AUTOMATIC GAGE CONTAINING VIBROTRON.
(b) CLASSIFYING RELAYS CONTAINING VIBROTRON.





MEMO: See the small ball tip near the pencil point? It is sensitive to displacement —and we DO mean sensitive. It can detect changes in dimension smaller than *one millionth of an inch.*

The trick is done with a Vibrotron actuated by the ball tip.

The Vibrotron is one of the most versatile instrument components ever devised. It is not sold separately but licensed to manufacturers for incorporation into sensitive instruments. It will do other things beside measure displacement. If you have a problem in instrument design involving the precise generation, control or measurement of audio frequency—or if you are concerned with the measuring of a quantity precisely at one place and indicating it at a distance, over variable transmission channels, we will appreciate hearing from you. Possibly, we can help you with a Vibrotron designed for your needs.

A description of your problem will incur no obligation. Write on your letterhead, please.

SOME APPLICATIONS OF VIBROTRONS:

- Anemometers
- Barometers
- Cardiographs
- Dew Point Meters
- Extensometers
- Frequency Meters
- Gravimeters
- Hygrometers
- Inclinometers
- Jamin Tubes
- Keying Monitors
- Locating Devices
- Magnetometers
- Null Indicators
- Oscillators
- Pressure Meters
- Q-Meters
- Radiosondes
- Sorting Devices
- Time Controls
- Ultrasonic Generators
- Vibration Analyzers
- Weighing Devices
- X-Ray Controls
- Yield Point Testers
- Zymometers

RIEBER RESEARCH LABORATORY
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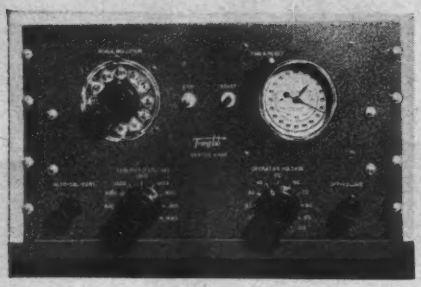
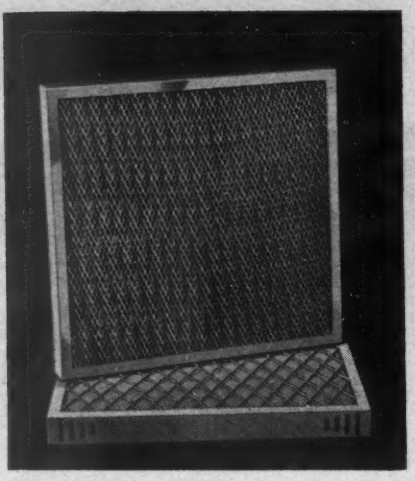
TOLERANCE	DRAWN TRACED CHKD	APPVD DATE SCALE	718



Impulse Counter

Tracerlab, Inc., 55 Oliver St., Boston 10, Mass., has developed the "Autoscaler", an instrument for counting and timing a predetermined number of impulses from a Geiger-Mueller tube. The scaling and timing circuits operate automatically for counts of 128 to 4096 impulses and have fully electronic control circuits. Overall resolving time of input amplifier and scaling circuits is less than 5 microseconds. Operating voltages for the Geiger-Mueller tube are supplied by the unit and two controls permit adjustment of threshold and operating potentials.—Electronic Industries

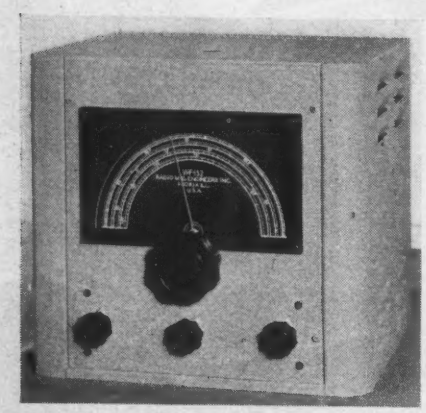


Air Filter

A blower motor filter for radio transmitters is being offered by Air Filter Corp., Milwaukee, Wis. The filter may be used as dry or as viscous filter for extreme dust conditions. The unit, which is designed to trap dust particles and retard moisture is constructed of formed steel frames and may be cleaned.—Electronic Industries

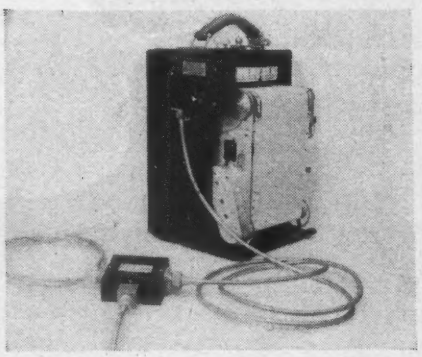
Crystal

A compact crystal unit for use in private aircraft transmitters working on 3105 kc is available from Bliley Electric Co., Erie, Pa. Type VX2 is also supplied in any specified frequency between 3 and 11 mc.—Electronic Industries



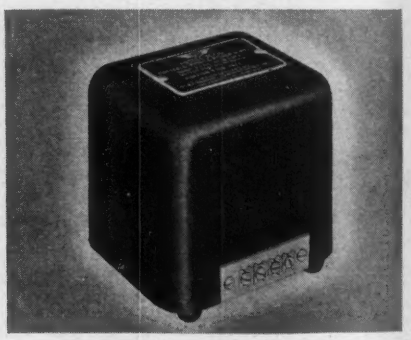
Converter

Radio Mfg. Engineers, Peoria 6, Ill., has brought out the VHF-152 converter for use on the 2-, 6- and 10-meter amateur bands. The preselector uses miniature tubes in a temperature-stabilized double conversion circuit. The tube line-up includes a 6AK5 rf amplifier and mixer, 6AU6 detector and 6J6 oscillator. An antenna change-over switch is provided. The converter has a built-in power supply for operation on 115 volts, 50-60 cycles, ac.—Electronic Industries



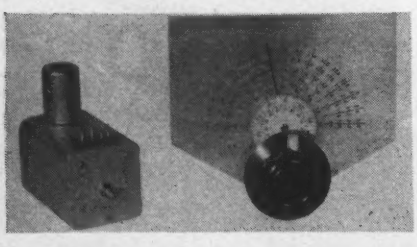
Field Strength Recording Drive

For field strength surveys of transmitter service areas, two accessories have been developed by Clarke Instrument Corp., 4236 45th St., N.W., Washington 16, D. C., to facilitate coupling of standard Esterline Angus recorders to auto speedometers. The type 102 recorder drive provides chart speeds of 1, 2, 4, 8 or 16 in. of chart per road mile and is coupled to the speedometer by means of the type 101 Speedometer Tee, a three-way flexible shaft coupling, mounted on the dash or bulkhead of the car. Equipment includes all necessary cables and may be disengaged instantly to permit normal operation of the recorders.—Electronic Industries



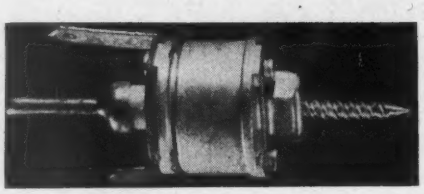
Portable Power Supply

A vibrator-type power supply for amateurs designed to operate from a 6 volt battery source is in production at Electronic Laboratories, Indianapolis, Ind. The unit supplies 300 volts dc at 100 ma with a regulation of 3.8% between no load and full load—Electronic Industries



Variable Frequency Oscillator

A permeability-tuned variable frequency oscillator covering the amateur bands in harmonics of 3.2 mc with a stability within 0.015% is being offered by Collins Radio Co., Cedar Rapids, Iowa. A linear range from 1600 kc to 2000 kc is covered in 16 turns of the vernier dial. The 70E-8 provides a usable output of 10 volts for driving a class A rf stage. The instrument is factory-calibrated using a standard checked against WWV.—Electronic Industries



Low-Loss Trimmers

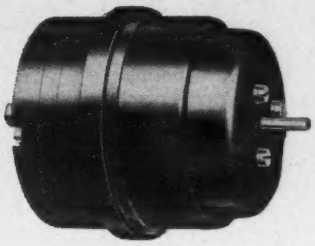
Hi-Q air capacitors developed by the Philips Laboratories in Holland, are now available from North American Philips Co., 100 E. 42 St., New York. The units consist of two sets of concentric aluminum cylinders which are rotatable along a common axis, and have high mechanical and electrical stability. Capacitance range is 3 to 30 mmfd., to 500 mc and higher.—Electronic Industries

Electrolytic Capacitors

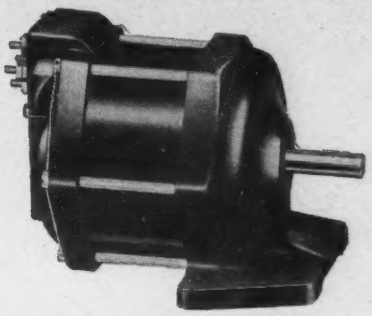
A line of compact, hermetically sealed "Tynee-Dry" electrolytic capacitors in single and dual section types is being offered by Pyramid Electric Co., 415-421 Tonnele Avenue, Jersey City 6, N. J. Units are available from 25 to 525 volts working voltage in sizes up to 100 mfd at 50 VWV, 4 to 40 mfd at 450 VWV and 8 to 16 mfd at 525 VWV.—Dual units are rated up to 20-20 mfd at 460 VWV.—Electronic Industries

(*Continued on page* 151)

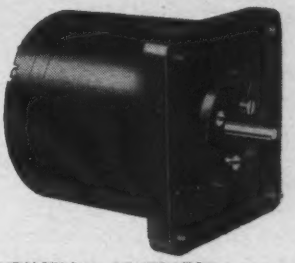
For precise, positive linkage between instrumentation and control



INDUCTION GENERATOR: when fed from AC source produces voltage proportional to speed of rotation. Used in circuits as velocity control component.

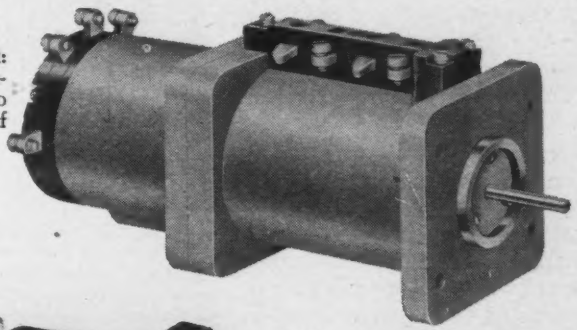


PERMANENT MAGNET GENERATOR: designed as AC potential source. Produces sinusoidal wave form with harmonic content under 2%.

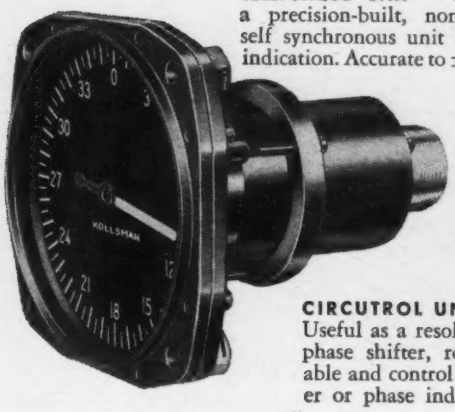


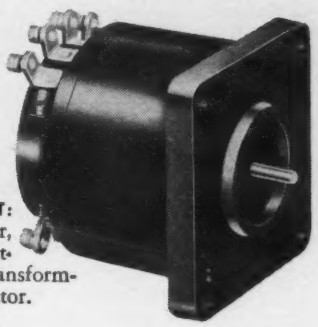
INDUCTION GENERATOR: type designed particularly for use where low residual voltage is required.

MOTOR DRIVEN INDUCTION GENERATOR: powered by 2-phase, low-inertia induction motor. Used as fast reversing servo motor where maximum stall torques of less than 7 oz. in. are required.

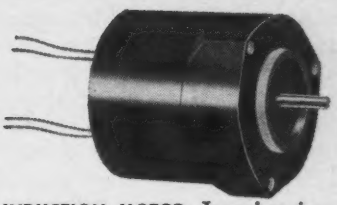


TELETORQUE UNIT — below left: a precision-built, non-motoring, self synchronous unit for remote indication. Accurate to ± 1 degree.





CIRCUTROL UNIT: Useful as a resolver, phase shifter, rotatable and control transformer or phase indicator.



INDUCTION MOTOR: Low inertia, two-phase squirrel cage unit for use as precision servo motor.

KOLLSMAN OFFERS A LINE OF SPECIAL PURPOSE AC UNITS

To meet the varying needs of the electronics engineer in linking instrumentation up to control, Kollsman offers a group of units with sufficiently varied functions to solve a wide range of control problems. In nearly every case, units are available for operation at various voltages and frequencies to fit widely diversified electronic control and remote indication applications. These Kollsman units are the outgrowth of long development in aircraft instrumentation and control and — more recently — Kollsman's considerable work in this field for naval and military applications. They are light in weight, compact, and highly precise, so that engineers working with exact quantities will find them reliable to a high degree. Complete data on any or all of these units may be had upon request. Kollsman Instrument Division, Square D Company, 80-08 45th Avenue, Elmhurst, N. Y.

KOLLSMAN AIRCRAFT INSTRUMENTS

PRODUCT OF

SQUARE D COMPANY

ELMHURST, NEW YORK • GLENDALE, CALIFORNIA

★ TELEVISION TODAY* ★

New Developments in the Video Field

TBA Tele Exhibit Practically Sold Out

Practically all the space (15,000 sq. ft.) allotted to exhibitors at the forthcoming Second Television Conference and Exhibition has been signed for and it appears certain that the affair will be a sell-out both insofar as exhibits and attendance are concerned. The date is October 10 and 11 and the affair is to be held at the Waldorf-Astoria in New York under the auspices of the Television Broadcasters Association. Ralph B. Austrian, general chairman suggests early reservation both for the conference and for hotel rooms which are still difficult to get unless asked for well in advance.

The conference program is a lengthy one with many speakers of national prominence. They will discuss latest developments in the industry with particular emphasis on current trends and future possibilities. There is to be a special luncheon on the first day with a talk by a prominent personality, a luncheon with entertainment on the second day and the annual banquet with surprise features, presentation of the Awards of Merit and an address by a national figure on the last day. Registrants may attend all meetings and food functions, and in addition will receive a copy of the annual TBA Television Book as well as a full transcript of conference proceedings. Registrations may be sent to Ralph Austrian, suite 1038, 500 Fifth avenue, New York; hotel registrations are being looked after by D. K. de Neuf, Raytheon Mfg. Co., 60 East 42d street, New York.

DuMont Video For Detroit's WWJ

Station WWJ, Detroit, will be the first newspaper-owned broadcasting organization to enter the television field. The company has just signed with the Allen B. DuMont Laboratories for a modern television station including master control, video transmitter, audio transmitter, motion picture film studio equipment, film electronic pickup chain, film projecting equipment and a special antenna. The antenna will be atop the Penobscot building, Detroit's highest structure. The station will be in operation by November 15.

BIKINI TELE

Here, together with Capt. Charles F. Horne, deputy director of communications department of U.S. Navy, are the miniature transmitter (left), with image orthicon tube, used on drone plane, and the receiver installed on the correspondents' press ship for the Bikini atom bomb tests. Both instruments are RCA equipment

French Plan Fax Newspaper Venture

Finch facsimile equipment soon is to be installed for the publication of a radio newspaper in France. Aristide Blank, publisher of France-Soir hopes to blanket France, Belgium and Algiers. The plan is to transmit a master newspaper from a central point to be picked up by radio on Finch receiving duplicator units located at key points. The duplicator unit cuts a stencil, usable on a standard Mimeograph machine for runs up to 50,000. The agreement between the French company and Capt. W. G. H. Finch also provides for the manufacture of Finch equipment in France.

Radar for Stratovision

The Westinghouse-Martin airplane plan to broadcast television and FM from ships flying over various strategic locations has progressed to the point where an application has been made to FCC for the use of radar equipment for navigational aid. Plan is to use Raytheon radar to keep track of the positions of the Stratovision planes.

Electronic Newspaper Trial in 12 Cities

The electronic newspaper, delivered through the air on radio waves, will be given a trial in more than 12 metropolitan centers early next year it is indicated in an order placed with General Electric for what is believed to be the largest number of facsimile transmitters and receivers ever ordered.

John V. L. Hogan, president of Radio Inventions, Inc., placed the order on behalf of Broadcasters Faximile Analysis, which is a group including 22 broadcasters and newspapers. This group was organized late in 1944 to study the new medium and develop appropriate transmitters and receivers. This work was done by Radio Inventions both in their laboratories and in the field. G. E. has been asked to make the equipment.

Four 9½ by 12 in. pages of text or photos can be relayed by radio from any FM broadcasting station to the home or office recorders during a 15-minute broadcast with the equipment. Printed pages emerge from a slot in the top of the receiver. A transparent window enables the owner to see the page as it is being recorded.

GE Will Operate Microwave Relay Net

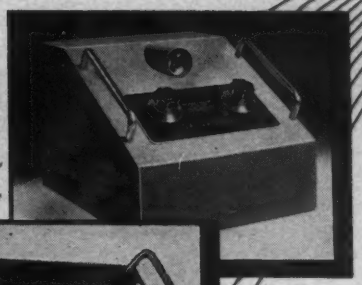
General Electric is to operate the three-station Schenectady-New York microwave radio relay network originally worked out by GE in conjunction with Globe Wireless and International Business Machines Corp. Licenses are to be transferred to GE, which will "prove in" the system, after which Globe may exercise its option to buy the network facilities. Plan is to carry television, FM, facsimile and business machine circuits.

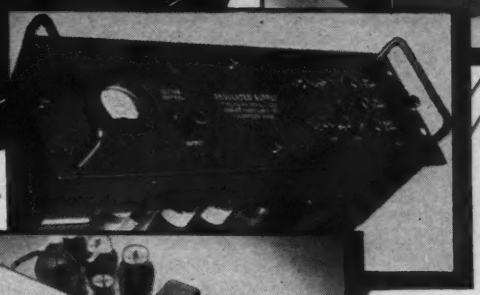
CBS Signs Ford

Columbia Broadcasting System has signed Ford Motor Co. for a series of video broadcasts from station WCBW—in black and white. Broadcasts will cover major sports events held in Madison Square Garden, except boxing.

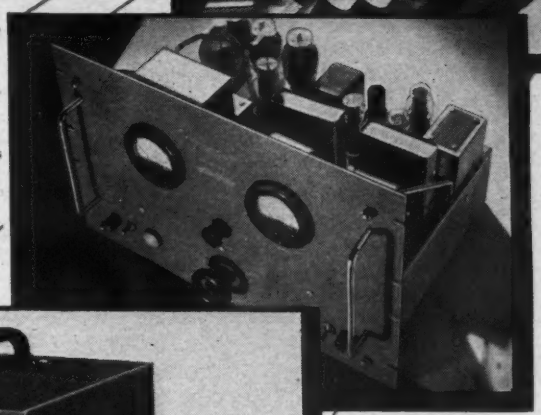
*Title registered U. S. Patent Office.

LOOK TO HARVEY of CAMBRIDGE

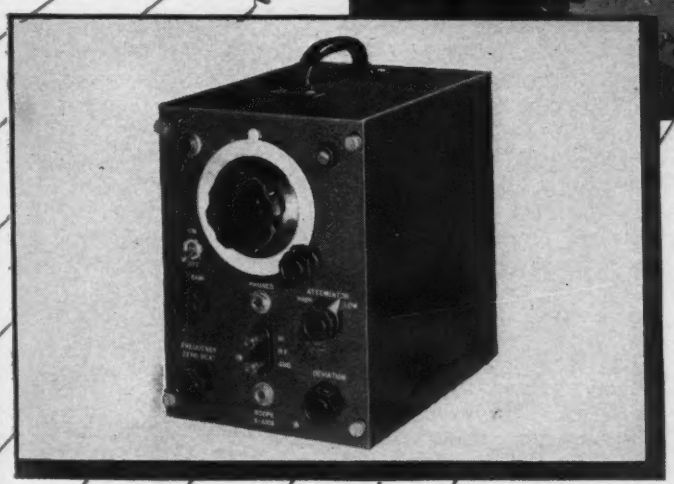




The HARVEY GALVASCOPE provides a vibration-proof, noise-proof, precision method of visually detecting 1,000-cycle bridge balance.



The HARVEY Regulated Power Supply 106 PA is a controllable, dependable source of laboratory D. C. power. Range 200-300 volts at 140 ma.



The HARVEY Regulated Power Supply 206 PA, a source of laboratory D.C. power that operates precisely and efficiently in two ranges: 500-700 volts at 250 ma; 700-1000 volts at 200 ma.

The HARVEY Visual Alignment SIGNAL GENERATOR Model 205 TS for development, experimental and servicing work in connection with FM applications, I-F amplifier alignment, and in other uses where a sweep deviated signal source is needed in the frequency range of 100 kc to 20 mc.

Pictured are typical HARVEY of CAMBRIDGE products that are helping industry work better, faster and at lower cost. Some were developed to meet the needs of HARVEY of CAMBRIDGE clients—others the result of HARVEY'S determination to discover the best and surest methods of doing specific jobs.

Write for bulletins

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HARVEY RADIO LABORATORIES, INC.
441 CONCORD AVENUE · CAMBRIDGE 38, MASSACHUSETTS

NEWS OF THE INDUSTRY

NAB Slates Session for FM Exclusively

In connection with its 24th annual convention, scheduled for Chicago (Palmer House) Oct. 21-24, National Association of Broadcasters will hold a luncheon and special session devoted to FM exclusively. The convention proper will open on Monday and continue through till the following Thursday, the FM session being held during the afternoon of the first day.

The names of panel members for the special session on frequency modulation broadcasting include Charles R. Denny, acting chairman of the Federal Communications Commission, who will discuss Commission policy concerning FM.

Station promotion and program sources will be discussed by Lester H. Nafzger, general manager of WELD, FM station in Columbus. He is also chief engineer of WBNS in Columbus.

W. R. G. Baker will appear as a representative of the Radio Manufacturers Association to discuss the transmitter and receiver situation.

T. A. M. Craven, vice-president in charge of engineering for the Cowles Stations, will cover the subject of technical operations.

Walter J. Damm, chairman of the NAB FM Executive Committee and president of FM Broadcasters, Inc., will preside and answer questions concerning managerial and operational aspects of FM broadcasting.

Arrangements for the FM panel are being handled by Robert T. Bartley, director of NAB's FM department. It is being set up under joint sponsorship of NAB and FM Broadcasters, Inc.

RTPB Elects

Radio Technical Planning Board re-elected two of its officers at a New York meeting July 10 and added two new ones. J. L. Middlebrooks, recently appointed director of engineering for National Association of Broadcasters, becomes the new vice-chairman, taking the place of Howard Frazier, who left NAB to open his own office as a consulting engineer; and George W. Bailey, executive secretary of IRE and president of the American Radio Relay League, becomes secretary, vice Dr. Wm. Crew of IRE who served last year. Re-elected were Chairman Haradon Pratt of Mackay Radio and Telegraph Co., and Treasurer Will Baltin of Television Broadcasters Association.

Propose 30 kc Separation for AM

Full agreement between the FCC and the broadcasting industry was reached in the revision of the Standards of Good Engineering Pratice for AM-standard broadcasting, it was brought out at an oral argument before the entire Commission August 5. The standards, however, are to be used as a major element of determination in the clear channel broadcasting controversy, final hearings in which are slated for September 8.

The most significant proposal in the revision of the AM engineering standards was the idea of a 30 kc separation for stations in the same area instead of the present 40 kc separation. But it was emphasized by high Commission sources that the 30 kc separation would be used in exceptional cases where technical circumstances proved it beneficial and would not be utilized in connection with existing broadcasting stations or even new ones except with the above qualifications.

Urge OPA Remove FM Set Ceilings

On July 26, the Office of Price Administration ordered price ceilings removed from television receivers for home use "because of the present limited demand due to the few sending stations and limited range, together with very high installation costs and the lack of base-period prices in use in fixing ceiling prices."

Learning of OPA's action on television receivers, the publishers of Electronic Industries and Radio & Television Retailing on July 30 telegraphed Hon. Paul Porter, director of OPA, as follows:

"OPA to be congratulated on removing ceilings from home television receivers. But exactly same reasons stated in your July 26 order —viz.:—limited demand, few sending stations, limited range, and high installation costs,—also apply to frequency-modulation receivers. Hence we respectfully urge that OPA also remove price ceilings from all home radio receivers incorporating FM bands, in order to permit American public to obtain benefits of this great new service to the home and farm.—M. Clements, O. H. Caldwell."

Conventions and Meetings Ahead

American Chemical Society—Chicago, Ill., Sept. 9 to 13. (Alden H. Emery, 1155 Sixteenth Street, N.W., Washington, D. C.).

Instrument Society of America—1946 Exhibit and Conference, Pittsburgh, Pa., Sept. 16 to 20. (Chairman of the Exhibit Committee, Paul Exline, P. O. Box 2038, Pittsburgh 30, Pa.)

American Physical Society—New York, N. Y., Sept. 19 to 21. (Karl K. Darrow, Secretary, Columbia University, New York)

American Institute of Electrical Engineers—Great Lakes District Meeting, September 26, 27, Fort Wayne, Indiana. (H. H. Henline, 29 W. 39th St., New York)

American Society of Mechanical Engineers—Boston, Mass. Sept. 30 to Oct. 3. (Ernest Hartford, 29 W. 39th Street, New York, N. Y. PE 6-9220.)

National Electronics Conference—Edgewater Beach Hotel, Chicago, Ill., Oct. 3, 4, 5.

Television Broadcasters Association Conference—Waldorf-Astoria Hotel, New York, N. Y. October 10 to 11. (Will Baltin, Secretary, Room 1038, 500 Fifth Ave., New York 18.)

Electrochemical Society—Toronto, Oct. 16-19. (Colin G. Fink, Columbia University, 3000 Broadway, New York, N. Y. UN 4-3200.)

American Welding Society—Annual Meeting, New York, N. Y., October 24. Atlantic City, November 17 to 22. (Miss M. M. Kelly, 29 West 39th St., New York, N. Y.)

Electronic, Radio and Television Exposition—Grand Central Palace, New York, Oct. 14 to 19. (Electronic Exhibitors. Harry G. Cisin, Executive Director, 50 Broad St., New York.)

Association of American Railroads, Communications Section—Annual Convention, Hotel Statler, Detroit, November 19-21.

Society of Motion Picture Engineers—60th Semiannual Technical Conference; Hollywood-Roosevelt Hotel, Hollywood, Calif., Oct. 21 to 25. (West Coast, H. W. Moyse; East, Harry Smith, Jr., Hotel Pennsylvania, New York)

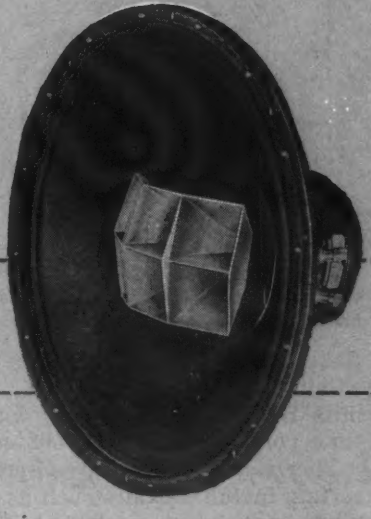
National Association of Broadcasters—Twenty-fourth Annual Convention; Palmer House, Stevens Hotel, Chicago, Ill., Oct. 21 to Oct. 24. **FM Session, open to nonmembers;** Palmer House, 12:30 P.M., Oct. 21.

Electrical Engineering Exposition—71st Regiment Armory, New York, January 27 to 31, 1947.

Institute of Radio Engineers—Annual Meeting (Commodore Hotel) and Show, (17th Regiment Armory) New York, March 3-7, 1947.

Announcing

ALTEC LANSING'S MODEL 603 MULTICELL DIA-CONE SPEAKER



Built to Quality Standards

Priced for Popular Appeal

For those who want a moderate priced speaker that can provide true high quality performance. Here it is—a superb speaker that's surpassed only by the famous Altec Lansing Duplex. Specially designed for limited budgets—Model 603 assures high frequency distribution, frequency response and undistorted reception expected of much higher priced systems. Learn more about the 603.

MODEL 603—Multicell Dia-Cone speakers incorporate a metal high frequency diaphragm and a 15" low frequency cone coupled by a mechanical dividing network to a 3" Voice coil of edgewise wound aluminum ribbon. Write for other details.

NOW AVAILABLE

$84.00

ALTEC
LANSING CORPORATION
1161 N. Vine St., Hollywood, Cal.
250 W. 57th St., N. Y. 19, N.Y.

"KEEP ADVANCING WITH ALTEC LANSING"

EXPANDING UTILITY

(*Continued from page 86*)

operational characteristics of the electronic devices will justify their use despite the increased cost. Obviously the detailed nature of these plant control systems will vary from one refinery operation to another.

There is a considerable use in the petroleum industry for devices capable of measuring metal thickness or liquid level from only one side of the pipe or tank. The Penetron*, which uses gamma ray scattering and electronic amplifiers and counters, is an example of such an instrument. There is room for improvement in the direction of decreasing the area over which the metal thickness is measured, of decreasing the time required to make a measurement, and of increasing the accuracy with which the thickness can be determined.

In many refining processes the provision of means of measuring quantitatively the amount of water or other foreign materials in the refinery stream is of considerable importance. At the present time, commercial devices capable of making such measurements are either not available or relatively unsatisfactory. The development of such instruments is by no means simple, since they must work satisfactorily in the field under a varied range of conditions. This field is being explored.

The calculation of material and quality balances for a complete refinery is a laborious and time-consuming job which is wasteful of manpower. The development of electronic computers, similar in purpose but not in detailed operation to the network calculators used so widely in the electrical industry, could make possible a great saving in time, and a net increase in the overall efficiency of refinery operation.

*"Penetron Detection of Corrosion," Felix B. Gordon and Philip H. Lipstate Jr., Penetron Service Co., Houston; The Oil Weekly, pages 38-39, June 17, 1946.

THERMAL DETECTORS

(*Continued from page 87*)

at frequencies in the audio range. It has a maximum response at about 2.5μ. Incidentally, a 923 or any other phototube, having S-2 spectral characteristics has a sensitivity extending up to .8μ, as in Fig. 2.

The two outstanding devices in the resistance variation field are the flake bolometer, (developed by the Bell Tel. Labs. and manufactured by the Western Elec. Co.), and the columbium nitride strip operating at temperatures approaching absolute zero, developed at Johns Hopkins University.

The former consists of thin flakes of thermistor materials, (in this case nickel, manganese and cobalt oxides). The small sizes of these

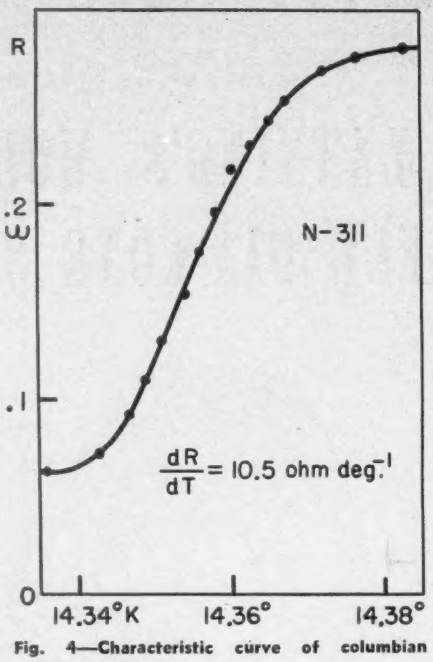


Fig. 4—Characteristic curve of columbian nitride bolometer

flakes make a ten-fold gain in sensitivity possible and moreover, permits high speed responses with a time constant of about .003 sec.

Thermistor materials, comprising certain metallic oxides such as uranium, magnesium, nickel, etc. have been described* with respect to their use as resistors with high negative resistance/ temperature characteristics. This effect is retained even with small flakes. They can be prepared to have a wide range resistance from 50 to 500,000 ohms/cm^3, and with a resistance temperature coefficient as high as 5% /°C. For bolometer use the material was prepared in thin flakes, .0002-.0005 thick and have an area of the order of 1 mm^2.

*Electronic Industries, Jan., 1944; p. 76.

The columbium nitride bolometer has a speed of response that permits recording 3000 cycle per sec. signals (down 6db). Columbium, a light gray metal is closely associated with the above mentioned tantalum. A thin ribbon (.2 x 0.01 x .00025 in.) is nitrided in an atmosphere of ammonia or nitrogen and mounted behind a rock salt window in an evacuated container maintained at a temperature in the range of 14 to 15°K. Fig. 4 shows a typical resistance/temperature curve about the point 14.36°K. A typical bolometer prepared in this way had characteristics as follows:

Resistance .....2 ohm
Active area .....1 mm^2
Time constant .....5 x 10^{-4} sec
Heat capacity of ribbon....25 ergs/°
Minimum detectable radiation pulse, 2 x 10^{-6} erg which is equivalent to
T = 1 x 10^{-7} degree
dr/dt = 10 ohm/degree

This bolometer is used in a bridge circuit with about 30 milliamperes passed through the ribbon and is so sensitive to heat that it can detect a temperature variation as small as one-millionth of a degree C. It is able to detect the warmth of a man's body a quarter of a mile away, locate ships at night and distinguish factory chimneys by

APPLICATIONS FOR SENSITIVE HEAT RECORDERS

ASTRONOMY—Measurement of radiation from a star.

INFRARED SPECTROSCOPY—Recording selective absorption over a range of frequencies in infrared region to indicate type of gases in the transmission path.

WEATHER STUDIES—Measurement of mean humidity over large distances by recording the attenuation of infrared transmission at selected wave lengths affected by water vapor (6.7μ).

OPTICAL PYROMETRY—Temperature measurements at a distance from furnaces, ingots, etc. using wavelengths not affected by water vapor, smoke, etc. (8-12μ).

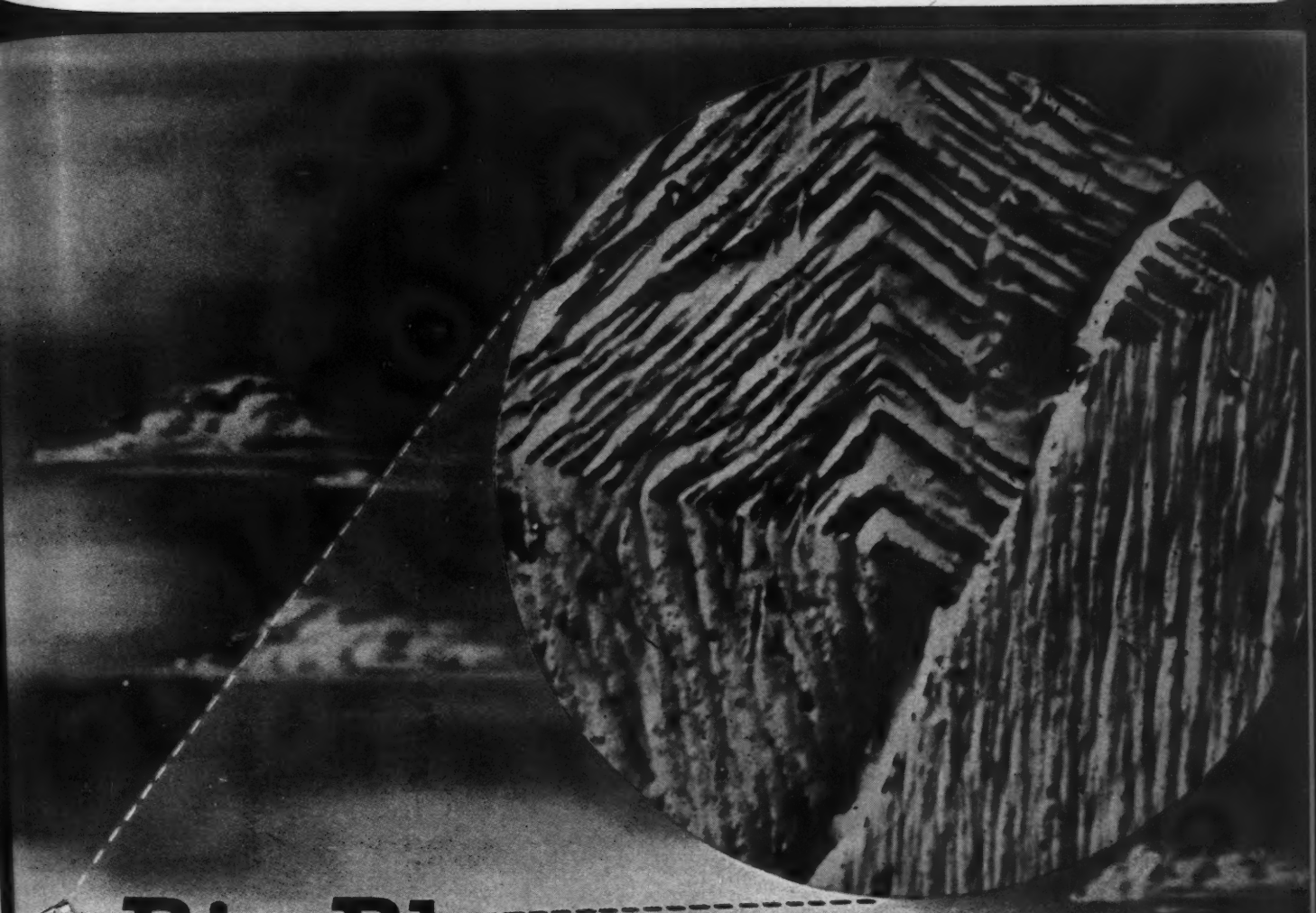
INFRARED VISION—Scanning viewed areas to determine presence and outline of heat radiating objects.

NAVIGATION—Applied to sextant for sighting the sun through clouds or to note presence of rocks, icebergs, etc.

RADIO FREQUENCY RESEARCH—Measurement of small radio frequency currents by noting their heating effect.

PHYSIOLOGICAL STUDIES—Involving measurement of small rapid temperature changes in body organs etc.

COMMUNICATION and SIGNALLING—Using infrared or visible light.



Big Blow-up...

Electronics and Photography work together to produce records like this 47,500-diameter magnification of chromium-iron surface

Magnified 47,500 times, the head of a pin would cover about as much area as a football field. Its apparently smooth surface would show irregularities as startling as these . . .

Electron micrography can produce magnifications even greater than this. The electron microscope, by itself, magnifies as much as 10,000 times and records images on photographic plates. And these images are so sharp, so well defined, that photography can enlarge them even more—often as much as 20 times more . . .

Because it plays this dual role in electron micrography . . . because it both records and enlarges . . . photography is an integral part of the new technic that is adding so much knowledge of such tremendous value to many branches of industry.

EASTMAN KODAK COMPANY
Industrial Photographic Division
Rochester 4, New York

ELECTRON MICROGRAPHY

. . . another important function of photography

Kodak

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Semi-Flexible COAXIAL CABLE

BETTER ON 3 COUNTS

√ **LOWER loss than plastic** 30% to 50% less loss than in plastic cables of same diameter.

√ **GREATER power capacity** Insulation does not melt or soften . . . develops less heat than plastic cables.

√ **LONGER lasting** Andrew cables are made entirely of copper and stone, two materials which have unlimited life and which impart the greatest resistance to crushing, corrosion and weathering.

ANDREW "FIRSTS" Here's proof of Andrew Leadership in the development of semi-flexible coaxial cables: 1) First to produce ⅜ and ⅞ inch soft temper cables in 100 foot lengths . . . 2) First to offer continuous coils of unlimited length with factory splicing . . . 3) First to offer lines shipped under pressure with all fittings attached.

Such continued leadership enables Andrew to offer *better* semi-flexible coaxial cables; cables that are better than those made from any other materials.

A complete line of coaxial cables, accessories, and other antenna equipment is produced by Andrew.

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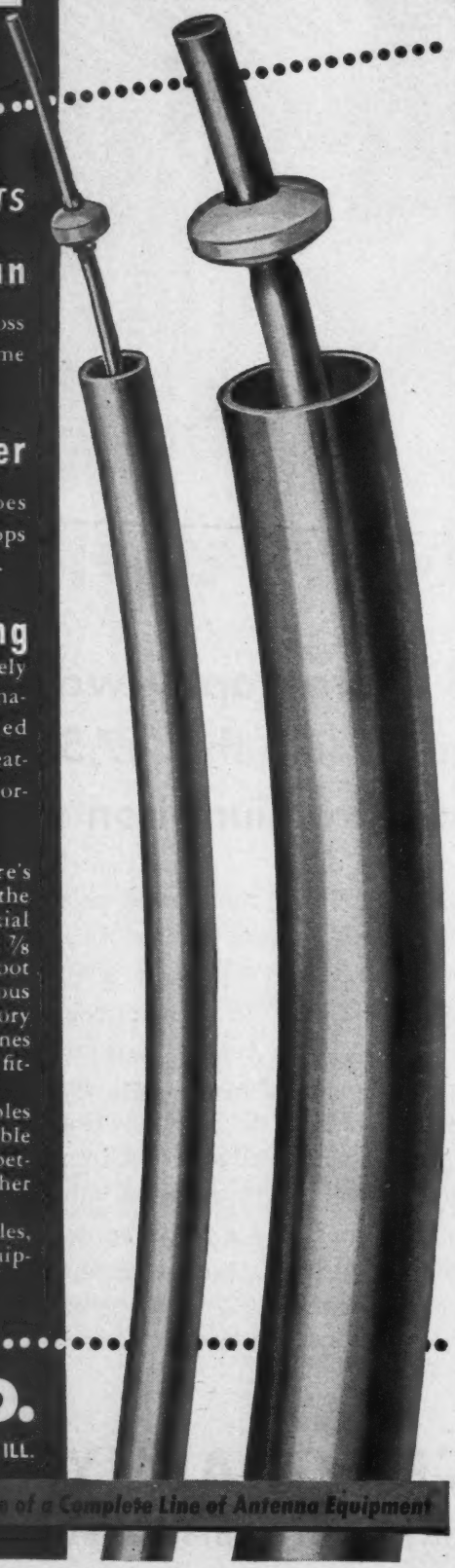
Pioneer Specialists in the Manufacture of a Complete Line of Antenna Equipment

These are the famous Andrew semi-flexible coaxial cables in ⅜ and ⅞ inch diameters (shown in actual size). Because of their better construction and design they are used throughout the world by thousands of broadcast, police, government, and military radio stations as the most efficient device for connecting antenna to transmitter or receiver.



their heat radiation. From high altitudes these thermistor bolometers can scan a completely darkened landscape and indicate the pattern of rivers by the difference in heat radiation between land and water For these applications the heat is collected in a parabolic reflector, Fig. 3, and focused on the bolometer element, which is connected to an amplifier. The latter transfers the information to an oscillograph or to loudspeakers, or to some form of graphic recorder.

OSCILLOSCOPE

(*Continued from page 97*)

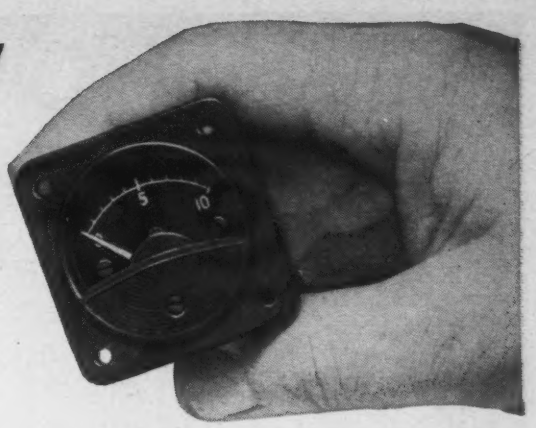
two microseconds duration and 60 volts peak amplitude. Both trigger pulses are available simultaneously at connectors on the front panel. The trigger generating circuit may be connected through a time delay arrangement to the internal triggered sweep and the two sections operated in synchronism. The action of the delay circuit is such that the output triggers may be made to lead or lag the start of the sweep by continuously variable amounts of time up to approximately 1000 microseconds.

Referring to Fig. 2 for circuit operation: V1 is a conventional multivibrator with a range from 200 to 5000 cycles per second. Output of this generator is differentiated and amplified in V2 and used to trip V3 which functions as a one shot multivibrator with adjustable width. The resistance inductance network in the first grid circuit of V4 is designed to form sharp negative pulses from negative wavefronts of V3. Positive pulses at the first anode of V4 are applied to the second triode which serves as a cathode follower and inverter output.

The triggered sweep circuit of Fig. 1 is arranged to respond to positive input voltage changes. However, the trigger forming stage, V4 of Fig. 2, will produce triggers only from negative grid excursions. When it is desired that the trigger pulses lag the sweep start, then the sweep is initiated from the fixed leading edge of the square wave at the second anode of V3. The trigger pulses will be formed from the negative trailing edge of this wave. The result is an adjustable delay between the trigger and sweep as the width of multivibrator V3 is varied.

To obtain the condition of trigger leading the sweep, the inputs are connected to the first anode of V3.

Here They Are!



The New 1½ INCH

G-E PANEL INSTRUMENTS

To meet the need for compactness, especially in electronic and communication devices, they have a body diameter of only 1½ inches, are less than 1 inch deep, and weigh only 3 ounces. They are accurate to within ±2 per cent.

These instruments are of the internal-pivot construction, and in addition to small size and light weight, they have all the other desirable features associated with this unique G-E design.

Because of its high torque and large-radius pivots, the element (which is common to both instruments) is well able to withstand vibration. High torque combined with a lightweight moving element results in fast response. Good damping makes for ease and accuracy of reading. Large clearances help to insure reliable operation.

All these features add up to a high factor of merit and all-round excellent performance.

For advance information, ask the nearest G-E office for Booklet GEA-4380, or write to General Electric Co., Schenectady 5, N.Y.

WATERTIGHT
TYPES DN-1, -2, -3
(Left hand, above)

● For applications where equipment may be used in an extremely humid atmosphere, exposed to rain, or accidentally submerged in water. Available for direct-current (DN-1), radio-frequency (DN-2), and audio-frequency (DN-3) service.

CONVENTIONAL
TYPES DN-4, -5, -6
(Right hand, above)

● For use on aircraft and on communications or electronic devices where the instrument is protected. Available for direct-current (DN-4), radio-frequency (DN-5), and audio-frequency (DN-6) service.

HEADQUARTERS FOR ELECTRICAL MEASUREMENT

THEY'RE G-E INTERNAL-PIVOT INSTRUMENTS

One advantage of the internal-pivot design is compactness. Armature, core, control springs, pivots, jewels, balance weights, and pointer form a single, self-contained unit, all parts of which are supported by a cast-comol magnet.

GENERAL ELECTRIC

By HAYDON AC
Timing Motors

HAYDON AC Timing Motors can be made to perform one revolution every 1000 hours or 27 million times as many. Whatever your particular requirement may be, a HAYDON AC Timing Motor can be engineered to fit.

More than a million HAYDON units now measure and motivate industrial operations.

SEND FOR ENGINEERING DATA BOOK

ELECTRONEERED TIMING
Haydon
MANUFACTURING COMPANY
INCORPORATED
Forestville, Connecticut

Trigger and sweep may also be started from opposite plates when no adjustable delay is desired. Circuit constants have been chosen so that operation of the phasing multivibrator is stable over the entire frequency range of the trigger generator multivibrator. Maximum phasing is approximately 1000 microseconds, or 80% of the time between successive cycles, whichever is the smaller.

Vertical amplifier

The vertical amplifier is conventional in design. Care has been taken to maintain wide frequency response consistent with good transient response. Sine wave response is flat within 10% to 4 mc per second with no positive slope at the high frequency end of the frequency coverage. Thus the transient response is such that a 100 kc square wave which rises or falls in the order of 400 volts per microsecond is faithfully reproduced.

Push-pull 807 tubes are used in the deflection amplifier to obtain adequate voltage swings to give a full screen image. The maximum sensitivity obtainable is about .05 rms volts per inch deflection, which has been found adequate for most purposes. A feature which has been added as a convenience is an amplitude calibrating system which makes it possible to check rapidly the peak voltage of a signal being observed. The input system is shown in Fig. 3.

The incoming signal is fed to a frequency compensated attenuator with steps of 100 to 1, 10 to 1, and 1 to 1. A variable ac voltage may be substituted at any time for the fraction of the input voltage appearing across the output of the attenuator. This may be adjusted by means of the CALIBRATE potentiometer until the calibration deflection on the cathode ray tube equals the deflection produced by the input signal. The value may be read on the calibration meter. If this is multiplied by the attenuation factor, the result is equal to the incoming signal amplitude. The values of voltage divider, R6 and R7, have been chosen so that the peak voltage at the junction of the two resistors is equal to the RMS value indicated by the meter, so that the meter effectively reads in peak volts.

Also included is a high-impedance, low-capacity probe for use where a minimum of circuit loading must be maintained.

The input system of the horizontal amplifier is similar to that

Here's How Radio Industry Says "OK"

TO FEDERAL's NEW MINIATURE SELENIUM RECTIFIER

TYPE-403D2625

NOW being used in radio receivers, voltage multipliers, speech amplifiers, PA systems, electronic organs, business machines — wherever a low-voltage low-current d-c source is required — replacing type 117Z6–117Z3 and other rectifier tubes.

The "landslide" of orders which followed the announcement of this new rectifier means just one thing — another outstanding contribution which fills a great need in the electronic industry. Now, in hundreds of applications, this 5-plate rectifier stack is proving its value — in money saved, reduced assembly time, new space savings, longer life, instant starting. It measures only 1¼ x 1⁵⁄₃₂ x ⅝ inches, and will go into restricted spaces where a tube and socket won't fit.

Though miniature in size, this rectifier embodies "full-scale" quality throughout, with **Center-Contact** construction and all of the other features which have made Federal Selenium Rectifiers the standard of quality in the industry. They're available now — in quantity. Write to department 0000 for prices and data.

CHARACTERISTICS:

Type 403D2625 Rectifier

Maximum RMS Voltage	130 volts
Maximum Inverse Voltage	380 volts
Maximum Peak Current	1200 ma.
Maximum RMS Current	325 ma.
Maximum DC Output	100 ma.
Approximate Rectifier Drop	5 volts

Federal Telephone and Radio Corporation

In Canada—Federal Electric Manufacturing Company, Ltd., Montreal
Export Distributors—International Standard Electric Corporation

An IT&T Associate

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FOR MICROWAVE TRANSMISSION

WAVEFLEX is the optimum flexible wave guide for microwave transmission in communication, television, and radar applications on vessels, vehicles, and aircraft. It is particularly adaptable in installations where vibration, shock mounting, or movement are present.

The extreme flexibility of Waveflex permits confinement in "tight" corners without distortion of critical dimensions of size and shape. Small radii bends are possible with practically no change in electrical properties, thus overcoming the loss of energy due to reflection in microwave transmission. Precision construction with silver-plated inner surfaces further reduce attenuation and preserves costly transmission energy.

A new bulletin with specifications is available upon request. Write to: Titeflex, Inc., 539 Frelinghuysen Ave., Newark 5, New Jersey.

Titeflex

WAVEFLEX — THE FLEXIBLE WAVE GUIDE WITH COMPLETE ELECTRICAL CONTINUITY

used in the vertical amplifier. The frequency response in this section has been maintained substantially flat to one megacycle. Maximum sensitivity is 0.1 rms volts per inch. Push-pull 6AG7's are used to provide deflection voltages.

Miscellaneous features

Among the many features of this instrument are provisions for direct connection to all deflection plates, external connection to cathode ray tube grid, 3000 volt accelerating potential for improved image definition and a voltage regulated power supply for stable hum-free operation. Panel controls have been functionally grouped for operational convenience. Mechanical construction is rugged and designed for both electrical efficiency and ease of servicing. The entire unit is self-contained in a wrinkle-finished steel cabinet 16 x 12⅛ x 20 in. with a total weight of approximately eighty pounds.

It should be noted that the refinements incorporated in this oscilloscope do not restrict its use to specialized applications but rather supplement the features of a standard oscilloscope, all of which are included with improved operating efficiency. Thus, the instrument will be equally useful for routine testing, production testing, and general application as well as for research on radar equipment, television, facsimile, or other laboratory research of an advanced nature.

INDUSTRY STUDIES

(*Continued from page 67*)

dle the most urgent problems.

The responsibilities of this electronic designer are great. Whereas, in most radio receivers a large and gradual loss in amplification would do no harm, because auxiliary controls are introduced to stabilize the results (i.e., automatic volume control), a minor variation in some characteristic in an industrial control circuit might throw the whole system into disrepute. A radio receiver designer uses tubes which have been developed for his use, whereas the industrial equipment designer generally also has to use the tubes designed for radio circuits. This is not too serious a handicap, however, since he has hundreds of tube types on the list from which to select.

His serious problem is to engineer the circuit so that normal variations in the operating charac-

Cardioid (heart-shaped) Polar Pattern. Wide-angle front pick-up, horizontally and vertically, diminishes sharply to dead zone at rear. Sound at rear dead zone cancels out and is not reproduced. Solves everyday sound problems—in a great many applications.

Only the Cardyne Gives You All This!

- New E-V Mechanophase* Principle
- True Cardioid Unidirectional Performance
- Reduces Background Noise, Reverberation
- Stops Feedback—Permits Greater Volume
- Relatively High Output
- New E-V Acoustalloy Diaphragm
- Substantially Flat, Wide-Range Response
- And other E-V Features

*Patents Pending

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NEW Electro-Voice CARDYNE

Now you get More Features...
More Advantages than ever...in a Single Head

Cardioid Dynamic Microphone

New E-V developments bring you true cardioid unidirectivity . . . smooth, wide-range response . . . high output . . . and other desirable advantages in a rugged single-head dynamic.

Through the exclusive new E-V *Mechanophase** principle, the CARDYNE virtually eliminates unwanted sounds . . . gives you only the sound you want, with greater definition and fidelity. Substantially reduces background noise and reverberation. Increases effective working distance from microphone. Stops feedback. Permits increased loudspeaker volume. Gives extremely accurate pick-up and reproduction of music and speech . . . indoors and outdoors. Highly suitable for the most exacting sound pick-up work . . . in studio and remote broadcasting, disc and film recording, public address and communications.

Trim, modern, functional design, finished in rich satin chromium. Smooth, firm tilting action. "On-Off" switch. Ruggedly built to withstand severe operating conditions. Available in 50, 250, 500 ohms impedance, or Hi-Z (direct-to-grid, 25,000 ohms). Low impedances balanced to ground. Also available without "On-Off" switch. *Send now for Cardyne Bulletin No. 131.*

CARDYNE II. Model 731. List Price **$75.00**
Frequency response, substantially flat, 30-12,000 c.p.s.

CARDYNE I. Model 726. List Price **$55.00**
Frequency response, substantially flat, 40-10,000 c.p.s.

No finer choice than

Electro-Voice

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made by engineers
for engineers.....
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teristics and possible slow changes in some of the parameters in regular operation, do not influence the results. It must be kept in mind that most of the noticeable effects of aging, etc., can be "engineered out" by circuit expedients.

Packaged units

The above remarks about packaged items do no hold for the large field of specialized industrial measurements. Many instruments are available wherein electronic principles have made valuable contributions to speed and accuracy. Here instrument men can find some form of "packaged" equipments that will measure almost any quantity. Nor do they pertain to the fields of high frequency heating and industrial communication where apparatus is available in almost any size and for any type of service. Another important field exists where electronically operated follow-up mechanisms provide rapid and accurate recorders and controllers. These instruments, of which there are several, are readily adapted to a wide range of applications.

It has been the experience in many plants that a large number of specialized jobs show up that definitely call for electronic methods. These may be in telemetering, timing, counting and in regulation services of all types. Apparatus is available for almost every problem in these groups. Another service for which equipment is readily adapted is that typified by printing registration, packaging and shearing to specified lengths.

Photoelectric controls

The "electronic art" was originally associated in the minds of many with the use of photoelectric devices. This field of application has long advanced out of the gadget stage, due to the availability of reliable instruments for many kinds of applications where light, color and vision are factors.

The opinion still prevails (and once in a while it is true) that doing it electronically is doing it the hard, expensive way. The field of high frequency heating was one that had to buck the problem of operating costs that are negligible for other types of heat. Successful in getting the right amount of heat where it is wanted quickly (as in the center of large masses) dielectric and induction heating is now being seriously investigated for

Crystal detector—1946 model

Remember the crystal detector in the first radios — hunting for the right spot with a cat's whisker? For years the detector lay discarded in favor of the vacuum tube. But when microwaves came, and with them the need to convert minute energy to amplifiable frequencies, a Bell Laboratories' scientist thought back to the old crystal.

Silicon of controlled composition, he discovered, excelled as a microwave detector. Unlike the old-style natural crystals, it was predictable in performance, stable in service. From 1934 to Pearl Harbor, the Laboratories developed silicon units to serve microwave research wherever needed.

Then Radar arrived. The silicon crystal came into its own, and found application in long-distance microwave Radar. Working with American and British colleagues, the Laboratories rapidly perfected a unit which the Western Electric Company produced in thousands. It became the standard microwave detector.

Crystal detectors are destined to play a big role in electric circuits of the future. They will have an important part in Bell System microwave radio relay systems. In various forms, they may reappear in radio sets. Here again Bell Laboratories' research has furthered the communication art.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED ECONOMIES AND IMPROVEMENTS IN TELEPHONE SERVICE

CLEAR SAILING FOR YOU.

Breathe deeply! Taste the tang of salt in the air? You're out from behind the eight ball, fellow, you're up there behind the mast. All your cares and worries are forgotten — leave your troubles to Macallen. Because if you use Mica in any form, Macallen has the vast resources, the wide technical knowledge and the extensive physical equipment to solve your problems perfectly.

And Macallen represents over half a century of working with Mica. Whether you make motors or generators, condensers or transformers, if you use Mica, then Macallen is your most reliable and dependable source of supply. For clear sailing ahead — leave your troubles to Macallen.

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THE MACALLEN COMPANY

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services where quick guesses would rule out the method from the matter of economy.

Returning to the industrial process control applications, most industrial plants are considering electronic methods along with the more readily obtainable hydraulic and pneumatic arrangements, to determine if the former have a place in a specific setup.

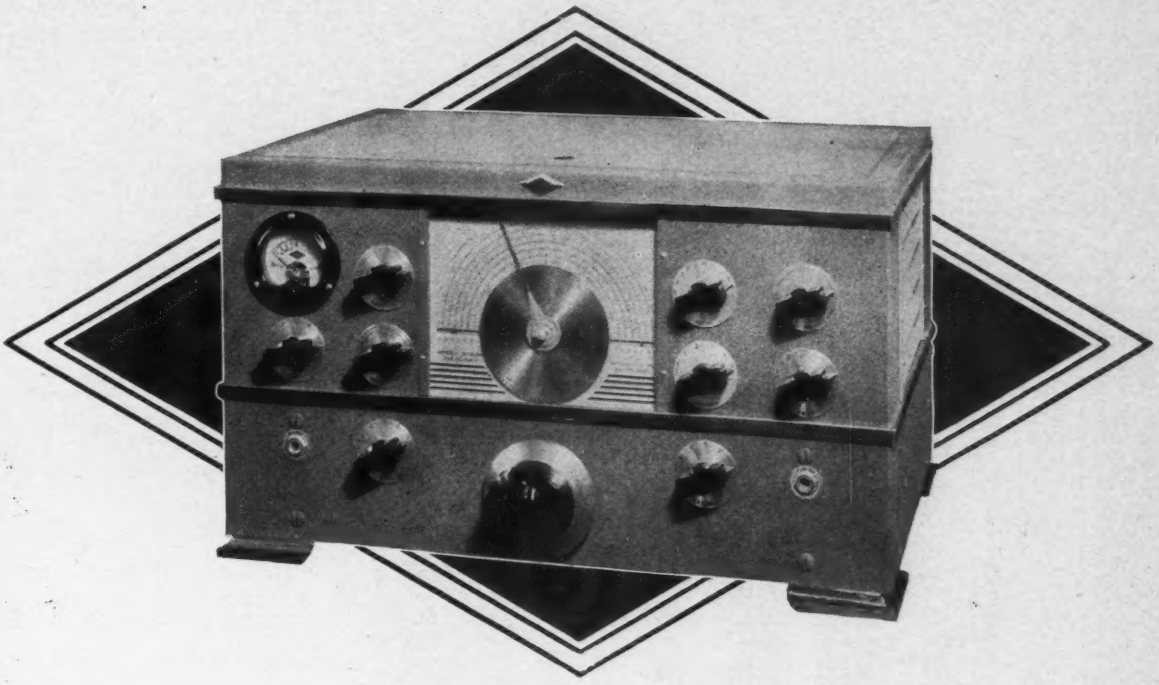
Relative cost

The installation expense of other systems depends primarily on the availability of suitable operating power. The drive for a final powered unit, such as a valve, may be either an electrical motor, solenoid, diaphragm or pressure operated plunger or cylinder. The cost of tubes, sockets and the usual accessories for a tube circuit may exceed that of a simple diaphragm motor unless conditions require special valve positioners, etc.

Electron tubes and accessories, per se, have been reduced to nominal costs because commonly available types are designed into the control equipment. In view of this standardization the costs of the electronic elements of the control are minor when compared with the expense of producing a few special machined parts which may be needed in either system. No conclusion can or should be drawn without investigation of all factors. Since wartime developments are just now being redesigned into new jobs, the correct answer now may not be the same in even three or six months.

One problem now being experienced by those associated with electronic equipment (producers and users) is providing an answer, the thought that an electronic control system should never have any moving parts, whereas in many cases a great deal of the same sort of apparatus used in other systems is in evidence. True, in some cases where the regulation of heat, power, and light is the end product, full electronic control is possible. In most other arrangements the final activation device can be a motor which again is easily adapted to do most anything that can be done manually since the main purposes of the tubes is to serve as the brain and nerve centers of control.

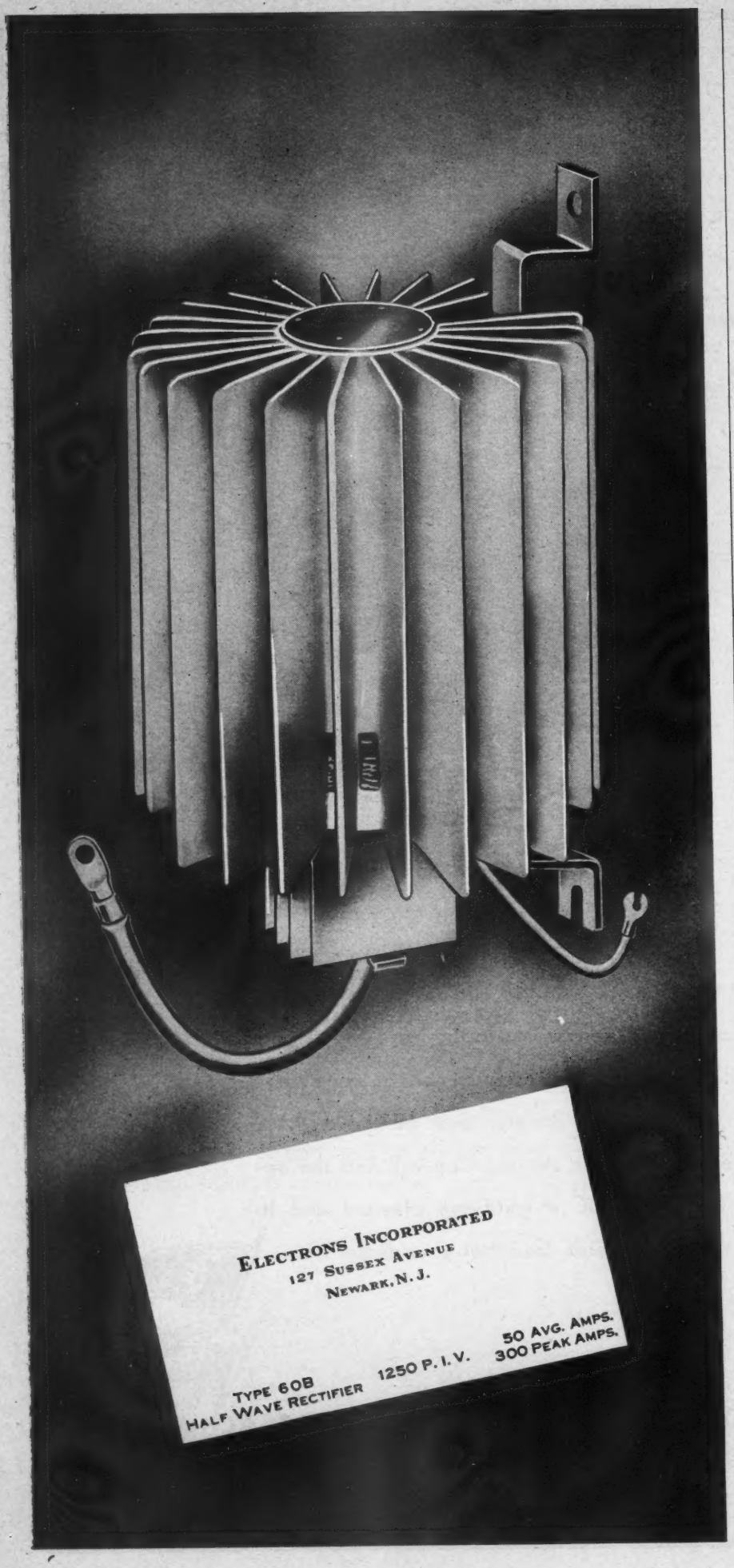
Finally, there have been large numbers of tube circuits developed to do ingenious things during the past twenty years. Military research and experience have pointed



THE NC-2-40C RECEIVER

Back of the superb NC-2-40C receiver stand National's twenty-five years of experience in building to the highest quality. In the NC-2-40C as in other products, National has excellence for sale. Stability and sensitivity are outstanding. Controls are convenient to the hand and smooth in operation. All important auxiliary circuits — wide range crystal filter, noise limiter, S-meter, beat oscillator, AVC — are present in advanced design. You will find the operation of the NC-2-40C a gratifying pleasure and its ownership a source of pride. See it at your dealer's.

NATIONAL COMPANY, INC. NC **MALDEN, MASSACHUSETTS**



out the importance of a number of particular operating principles and circuit technics that should greatly extend the range of application of tubes into new fields. A few of these are shown on the chart in this issue. Further details on these and other tube circuit design arrangements have been compiled in the Handbooks.* R.R.B.

*Electronic Engineering Handbook, by R. R. Batcher and Wm. Moulic, Caldwell-Clements Co., 480 Lexington Ave., New York.

Electronic Control Handbook, by R. R. Batcher and Wm. Moulic, Caldwell-Clements Co., 480 Lexington Ave., New York.

RADIO VOCABULARY

(*Continued from page* 71)

ROC—Gravity powered bomb controlled by television.

ROPE—Strips of tinfoil about 400 ft. long by ½ in. wide thrown from airplane to confuse enemy radar.

RUG—Another edition of "carpet."

SHORAN—Form of radar in which a mobile transmitter triggers a based transmitter.

SNIPERSCOPE, SNOOPERSCOPE—Military infra-red "seeing eyes" for observation in total darkness.

SONAR—Submarine detection system based on pulsed supersonic signals.

TR TUBE—Gaseous discharge tube for protection of radar receivers during periods of pulse transmission.

TUBA—Super power UHF transmitter for jamming enemy radar.

VT—Variable time proximity fuse detonated by self-contained radio transceiver.

WINDOW—Aluminum strips ¼ wave long thrown from airplanes to confuse enemy radars.

TUBES AND CIRCUITS

(*Continued from page* 75)

tions, the value of F will be less than one. For triodes a value of 0.25 can be used. For sharp cut-off pentodes, a value of about 0.5 can be used to take care of the division of current at the screen (variable mu pentodes will have a still greater value). If, in the above mentioned amplifier tube, the plate current is 2 ma, G_m is 1000 micromhos, and F is 0.5 for a pentode, then the equivalent shot noise voltage would be about 1.2 microvolts, which is less than that contributed by the grid circuit resistance.

Within the past few years many

Now . . . for

Control

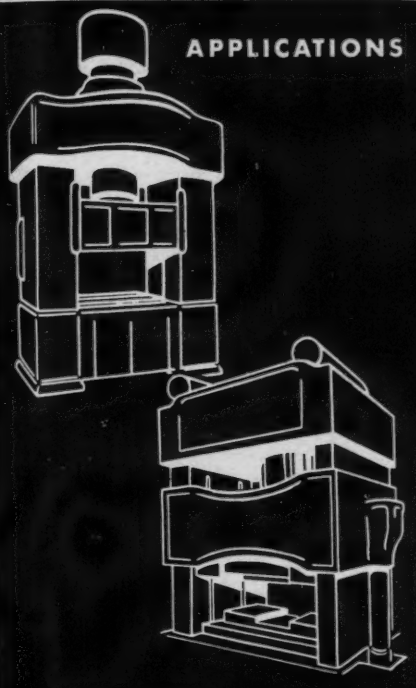
the FIRST time . . . you can

PRESSURES

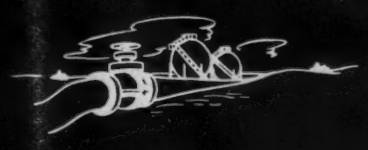
from 50 to 5000 lbs.

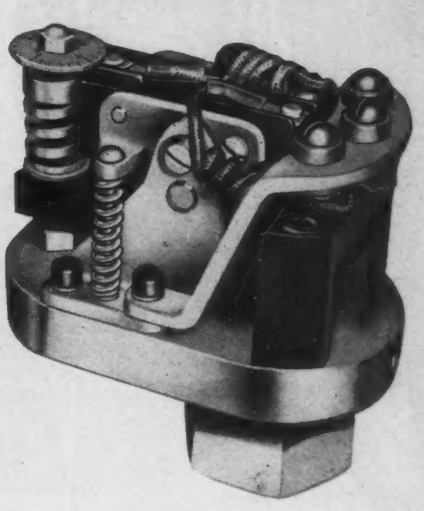
with ONE adjustable switch!

APPLICATIONS



The DiaFlex XPress Pressure Switch opens new fields to designers and users of heavy hydraulic presses, pneumatic tools, machinery and high-pressure equipment. It can be used to control actual operation, to monitor protective devices, to actuate a safety warning or alarm signal. Obvious uses are on large drop hammers, draw presses, forging equipment, machine tools, high-pressure process equipment and pipelines. Perhaps the requirements of your plant or products will suggest others.





THE NEW XPRESS PRESSURE SWITCH by DiaFlex permits closer control of higher pressures than has yet been possible. Adjustable and sensitive from 50 to 5000 pounds per square inch of gas or liquid pressures, the XPress is unusually compact and sturdy.

DESIGN CHARACTERISTICS

1 Operating pressure range 50 to 5000 psi.
2 Operating pressure differential less than 10% over entire range.
3 Instant dial adjustment at operating pressures.
4 Operates on pneumatic or hydraulic pressure impulses.
5 Sensitive and accurate within ½ of 1% over entire range.
6 Compact: only 3½" long x 2" wide by 4" high; weighs only 2¾ lbs.
7 Enclosed snap action contacts; dustproof and splashproof.
8 Rugged: will withstand rough handling and surge pressures up to 6000 psi.
9 Threaded pipe pressure connection; Amphenol or conduit electrical connection.

The XPress is but one of a complete line of pressure operated switches by DiaFlex. This division of Cook Electric Company is devoted to the design and production of precision products operated by the flexure of Cook's patented Spring-Life Bellows Diaphragms. You are invited to discuss your pressure control problems with the nearest Cook field engineer, or to write for further information. Please outline your requirements, and request Booklet PB.

DIAFLEX

division of **COOK ELECTRIC COMPANY** Chicago 14

Sales and engineering offices in principal cities.

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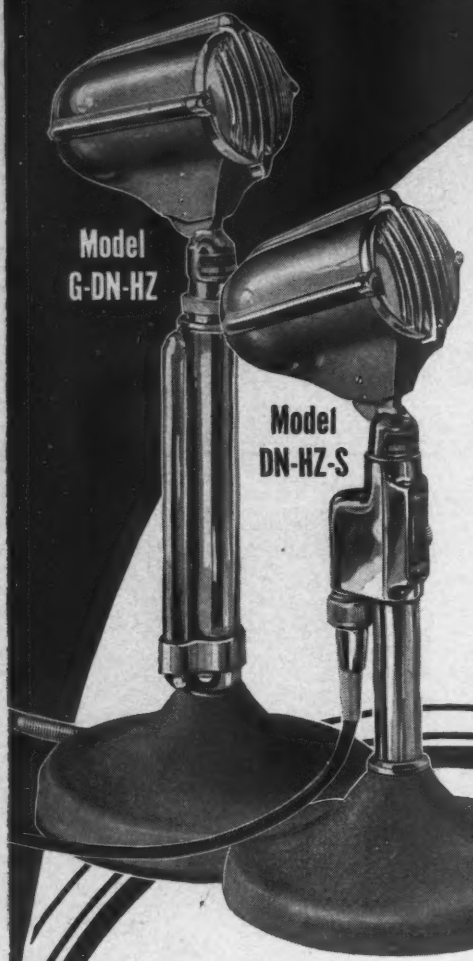

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DYNAMIC MICROPHONES

NEWLY DESIGNED AND ENGINEERED

● Incorporating advanced ideas in operation and design, Astatic DN-Series Dynamic Microphones are highly recommended for a wide variety of communications and public address applications, especially where temperatures vary and high relative humidity is encountered.

Four Models of different output impedances, are available: DN-50, DN-200, DN-500 and DN-HZ.

Any one of these models is available with the Type G, Grip-to-Talk Desk Stand. Only one model, however, DN-HZ-S, high impedance, is available with the Type S On-Off Switch. Astatic Dynamic Microphones are semi-directional in character, incorporate a unitary moving coil system and carefully proportioned acoustic circuit to highly damp the natural resonance of the moving parts and provide a response substantially flat from 50 to 7,000 cycles. All DN-Series Microphones are sturdy and dependable, relatively low in cost, smartly streamlined, attractively finished in opalescent gray with bright chrome grille, and sure to give long, satisfactory service.

THE Astatic CORPORATION

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CONNEAUT, OHIO

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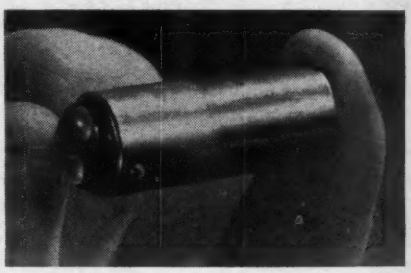
special circuits involving vacuum tubes have been developed and have become widely used. These circuits include the cathode follower amplifiers, the grounded grid amplifier, the combination of cathode follower and grounded grid amplifier or the cathode coupled amplifier, various gate, switching or trigger circuits, variable reactance circuits, counting and control circuits.

One type of application of increasing importance is a circuit with an alternating plate supply voltage. A number of applications of this type have been developed and their tube requirements differ from the ordinary application. The plate current that may be used to operate a small motor or some similar device is often quite high. This heats up the tube enough to cause its plate to become an emitter and, on the high negative plate voltage in the reverse half cycle, electrons



Miniature cold-cathode voltage regulator

may flow in the reverse direction to the grid and to the cathode, causing the tube to lose control. This type of application is one of those that requires different circuit design considerations than is used with standard receiver types, and may require specially designed tubes, if it is necessary to load them up to a point where high temperatures result.

Pulse applications have placed still different requirements on some tubes than have been considered previously. The cathodes have to supply the peak emission current which can be many times higher than the rated average current. Although the average dissipation of tube elements is kept constant, the dissipation in the cathode will be higher than it would be with an equal average current. Certain cathode materials and processing methods have resulted in higher emission capabilities for tubes made available for such applications.

Manufacturing limits on heater to cathode leakage in cathode types are usually given as the maximum

ADVANCE
RELAYS

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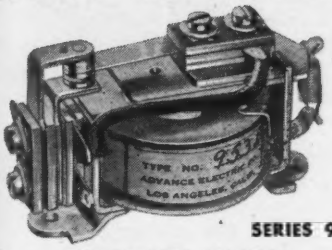
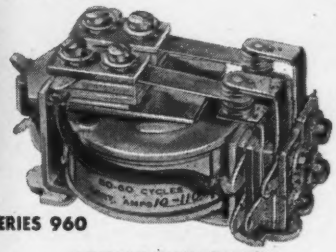


SERIES 950

SINGLE POLE RELAYS

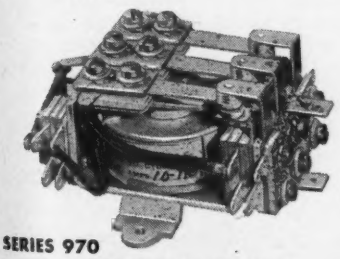
General Circuit control unit, inexpensive, yet highly efficient. Available in either single or double throw, open or closed contacts. Coils—1 to 115 v A.C.—2 to 60 v D.C. Size — 1½-in. x 1½-in. x 2-21/32-in.



SERIES 960

DOUBLE POLE RELAYS

Small, yet powerful relay suitable for light or power transfer systems. Available in either single or double throw, open or closed contacts. Coils—1 to 115 v A.C. — 2 to 60 v D.C. Size — 1½-in. x 1⅝-in. x 2-21/32-in.



SERIES 970

THREE POLE RELAYS

Very rugged, small relay. Available in either single or double throw, open or closed contacts. Coils—1 to 115 v A.C. — 2 to 60 v D.C. Size — 2½-in. x 2⅜-in. x 2-15/16-in.

A similar Four Pole Relay (SERIES 980) is available in full range of contact combinations.

Write for catalog and price list

Advance Relays

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allowable current that can flow between the heater and cathode when 100 to 400 volts (depending on the tube type) is applied between them. Typical maximum current values vary between 10 and 200 microamperes. Difficulty is sometimes encountered in high gain amplifiers, cathode followers, etc., when the circuit permits the heater to cathode leakage to introduce hum into the amplifier. This can be overcome by operating the first stages with fixed bias so that the cathode is at ground potential and any dc leakage is returned directly to ground without getting into the signal circuits. Hum due to heater-cathode leakage can also be overcome by operating the heaters on dc.

If, as in industrial equipment, a high degree of reliability is desired, it is advisable to design the equipment so that the heater cathode voltage never exceeds 100 volts. This can be accomplished by using separate heater transformers having good insulation, and shielding for tubes whose cathodes operate at a high voltage off ground.

Another source of hum pickup in cathode types may be due to heater-grid coupling because of leakage between the elements, plus electron coupling (emission due to contamination of active material in grid or heater), plus capacitive coupling. This can be minimized by using the lowest possible grid circuit resistance consistent with desired stage gain.

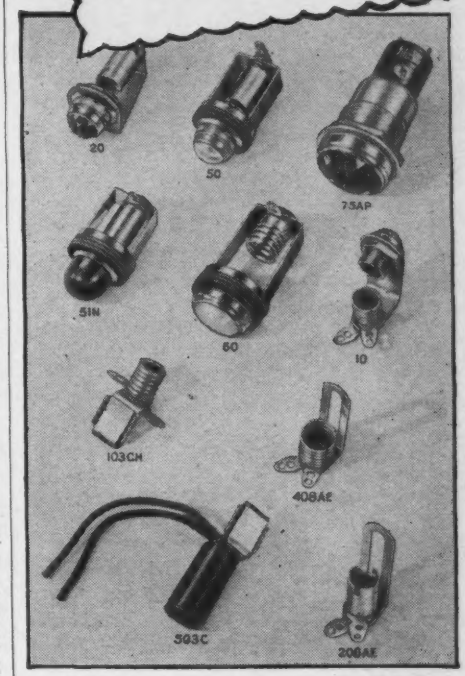
Insulation resistance

The JAN-1A specification for leakage resistance in most receiving tubes states that the leakage shall not be less than 10 megohms between any two elements except between heater and cathode where a different limit, varying with the tube type, is specified. The interelectrode leakage is measured with a potential of either 300 or 500 volts, depending on the rating of the tube involved.

Probably the type of leakage that causes the greatest trouble in conventional circuits is that between the plate or screen and the control grid. For example, assume a tube is being used with 100 volts anode and with a grid resistor of 0.25 megohms. If the plate to grid leakage is 25 megohms then there will be a positive voltage developed across the grid resistor of 1 volt which will be subtracted from the bias voltage.

Interelectrode leakage in conventional receiving tubes usually is a

CHECK THE PATENTED FEATURES AND GREATER ECONOMY OF DRAKE LIGHT ASSEMBLIES



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Made in five standard diameters. Black only. 1,000-1,500 yard spools.

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result of getter deposit on the mica separators which causes a leakage path. Tubes have been designed without mica to overcome this difficulty. Tubes of this type mostly rely on glass rods in the tube envelope for alignment of the tube elements, giving interelectrode leakages of several thousands of megohms. However, they are difficult to manufacture and have not been used in great numbers. Also, these tubes may not be rugged enough for some industrial applications. Interelectrode leakage has been reduced in some conventional receiving tubes by cutting slots in the mica or by spraying them with a mica coating to lengthen the leakage path.

In moist locations leakage on the tube base can become great enough to render some types of equipment useless. This is especially bad in equipment that is used intermittently or in battery-operated equipment where the heat generated in the case is slight. A continuously-connected light bulb or resistor can sometimes be used to remedy this. Dirt on the tube case is also objectionable, especially in the presence of moisture. War research on tropicalization showed that simply applied coatings of wax, silicone varnishes, etc., would largely eliminate moisture leakage over the surface of components.

Kesten Leaves CBS Board

Paul W. Kesten has resigned as vice chairman of the board and a director of the Columbia Broadcasting System. He will continue to serve CBS as a consultant.

Kesten joined CBS in July 1930 as director of advertising and sales promotion. In December, 1934 he was elected a vice president; in May, 1937 he was made a director; in October, 1943 he became executive vice president, and in January, 1946 was named vice chairman of the company's board of directors.

Design Consultants

A new firm, doing business as design consultants under the style Hadley, Ryder and Pederson, has been formed in Hartford, Conn. Donald L. Hadley, who will be design director, was formerly design consultant for the Westinghouse Electric Corp.; Carleton B. Ryder, executive director, was formerly coordinator of apparatus design for General Electric; Nicholas R. Pederson was formerly technical supervisor for General Electric.

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ELECTRIC SOLDERING IRONS

are sturdily built for the hard usage of industrial service. Have plug type tips and are constructed on the unit system with each vital part, such as heating element, easily removable and replaceable. In 5 sizes, from 50 watts to 550 watts.

•

TEMPERATURE REGULATING STAND

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For descriptive literature write 111-1

AMERICAN ELECTRICAL HEATER COMPANY
DETROIT 2, MICH., U. S. A.

BIKINI

(*Continued from page 79*)

fed to a pulse selector. Here the master pulse is separated out by virtue of its greater amplitude and the negative pulse inserted by the blanker also is separated out. These two sets of pulses are used to operate trigger circuits in a manner identical to that of the transmitter commutator. In this case, however, the inputs of all the converter tubes are common, while their outputs lead to separate tuned circuits which oscillate in a damped fashion at 10 kc between successive pulses. The voltage from the tuned circuit is amplified, rectified, and fed to a recording galvanometer

The transmitter and receivers proper were identical to the ones used in the water blast test and already described. The entire system was responsive to dc, i.e. a steady pressure applied to the gage on the target ship resulted in a constant reflection of the galvanometer on the receiving ship.

The three recording galvanometers had 14 elements each. Recording was done on specially sensitized photographic paper, eight inches wide and 300 ft. long. Time markers are supplied on the record by interrupting the 14 light beams successively, thus serving also as a method of distinguishing the various traces when they overlap. A sample record is shown in Fig. 7. An automatic calibrating arrangement was also provided for this equipment.

Two automatic selector switches may be set in operation by remote control, one selecting a given channel while the other applies successively 5 equal positive steps of voltages and 5 negative steps. The first selector then proceeds to the next channel, and the process is repeated. A record is thus obtained of the sensitivity of all channels immediately prior to the test.

In addition to the equipment described, literally tons of other apparatus was carried along. This included complete photographic processing materials and dark room equipment for developing and printing the records, spare parts for the telemetering gear, and sufficient test instruments and tools to furnish a reasonably good-sized electronics laboratory. Communication equipment for use between the target and receiving ships during adjustment of the equipment was also supplied. The entire project was planned and the equipment assembled, tested and shipped all within a period of seven weeks.

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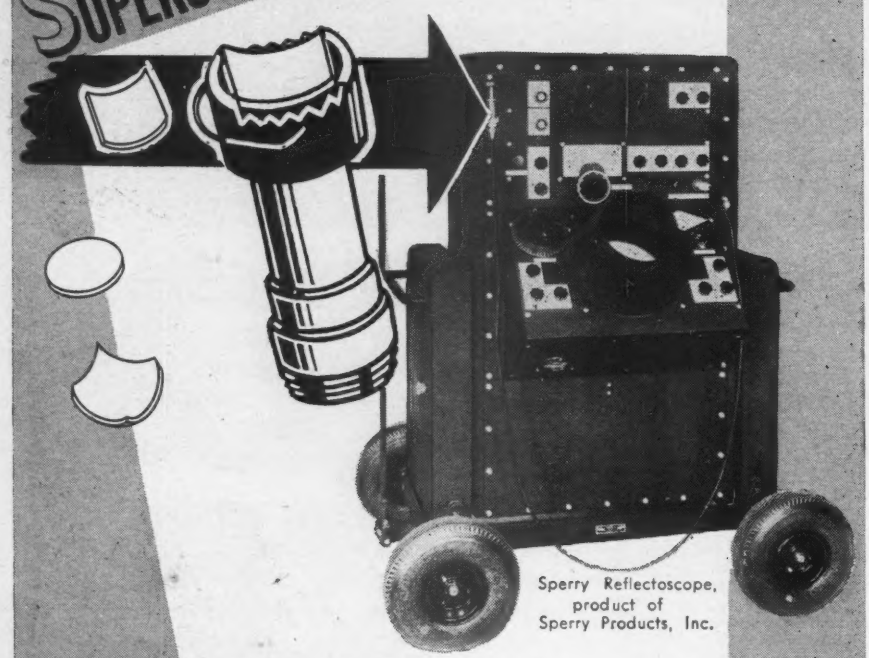

Sperry Reflectoscope, product of Sperry Products, Inc.

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DECADE COUNTERS

(*Continued from page* 84)

the suppressors are internally tied to the cathode. For clarity the grounded cathodes and suppressors are not shown in the circuit and neither are the control grids of the inner groups to which a negative bias is applied.

Negative bias is also applied to the outer pentodes sufficient to cut them off in the absence of signal. AC signals applied to the rings connecting alternate outer grids as shown cause triggering twice during each cycle.

As the plates of "on" tubes are connected to screens of "off" tubes, their potential is low. The converse is true with plates of outer off tubes and hence these pass current when the AC signal arriving is sufficiently large to overcome the grid bias. Such current lowers the plate voltage of the first inner "off" tube in a clockwise direction, turning it on and turning its opposite mate off. Here again the magnitude of triggering voltages is important, too high values tending to trigger the inner tubes directly.

*Design and use of Directly Coupled Pentode Trigger Pairs and Decade Counting Circuits by Victor H. Regener, U. of Chicago, Rev. of Sc. Inst., May, 1946.

WIDE READING

(*Continued from page* 101)

Selenium Photocells

W. Ch. van Geel (Philips Technical Review, Eindhoven, Holland, March, 1946)

Structure and performance of a blocking-layer selenium photocell are explained and current and voltage curve as function of illumination with the external resistance as parameter are presented. Because of its logarithmic response, the cell is particularly suitable in photographic exposure meters.

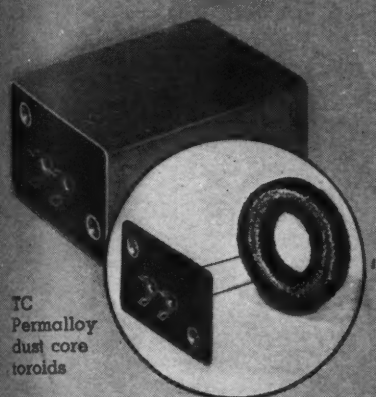
A Phototube for Dye Image Sound Track

Alan M. Glover and Arnold R. Moore; R. O. Drew and S. W. Johnson; J. D. Phyfe (Journal of the Society of Motion Picture Engineers, May 1946)

Because of the transparency of dyed gelatin to infrared light, to which conventional sound phototubes are responsive, the necessity for a different type phototube arose to be used with color emulsions.

Three articles dealing with the recently developed blue-sensitive

Toroidal Coils for high "Q"



TC Permalloy dust core toroids

Inductance — up to 2 hys.
Frequency—300 cy. to 30,000 cy.
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List Price . . . from **$4.50** to **$7.50**
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BF-10—Range filters to permit separation of the 1020 cy. beam signal from voice transmission. Employs unique method of impedance matching permitting use of minimum number of components. Weighs only 10 ounces and measures 1⅛"x1⅝"x3".

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CE-25 — Transcription equalizers for vertical recordings.

The above are designed in accordance with N.A.B. requirements.

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Filters for harmonic analysis on any special type of frequency discrimination.

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phototube, the 1P37, describe its application to transcribing dye image sound tracks recorded on color film for which purpose it was designed. Its performance is compared with that of the standard 868 tube which is sensitive in the near infrared and used for sound reproduction from black-white film. The new gas-filled tube may be readily interchanged with the 868 tube and is also suitable for ordinary silver tracks.

Effects of Humidity on Dielectrics

R. P. Field (J. of Applied Physics, May, 1946)

The formation of ionized water films on dielectrics under conditions of high humidity and the consequent changes in electrical properties of the material are studied. This investigation is concerned with surface phenomena and excludes changes in electrical properties caused by volume absorption which appear only after hours or days, while the surface film forms in minutes. It is established that the film forms very rapidly and that it is the gradual ionization of the film that is observed by measuring the reduction in surface resistivity with time.

In an atmosphere of 100% relative humidity, the conductivity of

Material	R	% RH per decade change of R	Recovery time in minutes after 100% RH for 1 hr.	16 hr.
	MMΩ			
Hydrocarbon wax, modified	>20		.0	.0
Cellulose acetate butyrate	>20		.0	.0
Silicone rubber	10		.13	
Polytetrafluoroethylene	3.6		.17	17
	kMΩ			
Polystyrene (sheet)	840		.13	.13
Polydichlorostyrene 2–5	29	7	.17	
Hydrocarbon wax	20	13	.17	
Ethyl cellulose	13	9	.33	.5
Cellulose acetate	7.0	6	1.0	6
Polyvinyl chloride acetate	5.7	12	6*	
Polystyrene (plasticized)	5.0	4	.17	62*
Phenolic, mica-filled	5.0	9	.17	13*
Aniline formaldehyde	4.2	4	.17	20*
Polyamide	3.8	14	200	
Porcelain, glazed	3.7	15	2.5*	
Glass (high K)	3.4	10	17*	20*
Mica	3.0	12	11	
Polystyrene (molded)	2.4	10	.17	.17
Polystyrene (plasticized)	2.4	8	.11	.17
Steatite (L-3)	1.6		.17	.75
Quartz	1.4			
Polyethylene	1.3	9	17	.17
Phenolic, XX	1.3	16	80	
Phenolic, asbestos filled	1.2	9	1.5*	100*
	MΩ			
Phenolic, XXXP	660	15	300	
Steatite (L-4)	640		.5	1
Phenolic, LE	500	18	400	
Phenolic, mica-filled	320	8	40*	
Steatite (L-4)	280		.33	
Polydichlorostyrene 3–4	240	6	.33	5.3*
Phenolic, cellulose filled	240	10	400	
Aniline formaldehyde, glass matte	240	9	14	1000
Phenolic, C	220	16	300	
Vulcanized fibre	220		6000	
Aniline formaldehyde, glass cloth	200	12	3	
Quartz	190			
Phenol formaldehyde (plasticized)	100	12	25	
Glass (sintered)	90			
Glass bonded mica	64	18	400	
Melamine, glass cloth	38	14	300	
Phenolic, mica filled	30	11	7*	

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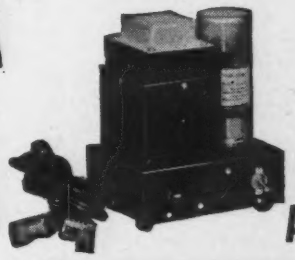

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Now, in radio chassis and similar applications, both small and large units can be vertically-mounted with standardized assembly techniques—with uniform appearance in the finished product.

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CHICAGO, 18

several dielectrics was observed to reduce within one minute to about ten times its equilibrium value which is attained within an hour. Values of the equilibrium surface resistivity, R, arranged in order of decreasing resistivity, are listed in the first column of the table. The equilibrium value is a logarithmic function of relative humidity; the percent change in relative humidity for a variation in resistivity by a factor of ten is found in the second column of the table. The third and fourth columns give the recovery times in minutes after exposure to 100% relative humidity for one hour and for sixteen hours, respectively. The film is actually very thin and vanishes within 10 seconds at zero percent relative humidity except for thicker films which may be present as a result of dew point condensation; forced ventilation removes this film also within 10 seconds.

As the film forms, both, capacitance and dissipation factor increase. For a quartz bar, the frequency is constant over the audio range and the dissipation factor varies inversely with frequency. The behaviour of L-4 grade steatite, as the frequency is varied, indicates interfacial polarization. Capacitance increases rapidly with decreasing frequency and dissipation factor decreases slower than inversely with frequency. A detailed study was made on an unprotected 1000 micro-microfarad mica capacitor where interfacial polarization could also be established.

Maxon Takes Victor

Victor Electric Products, Inc., Cincinnati, long prominent in the fractional horsepower motor and appliance field, has been acquired through stock interchange by W. L. Maxon Corp., New York. Maxon produces a similar line. Engineering staffs of both companies will collaborate on development of a number of new products in the electro-mechanical field.

Ripley N. Y. Office

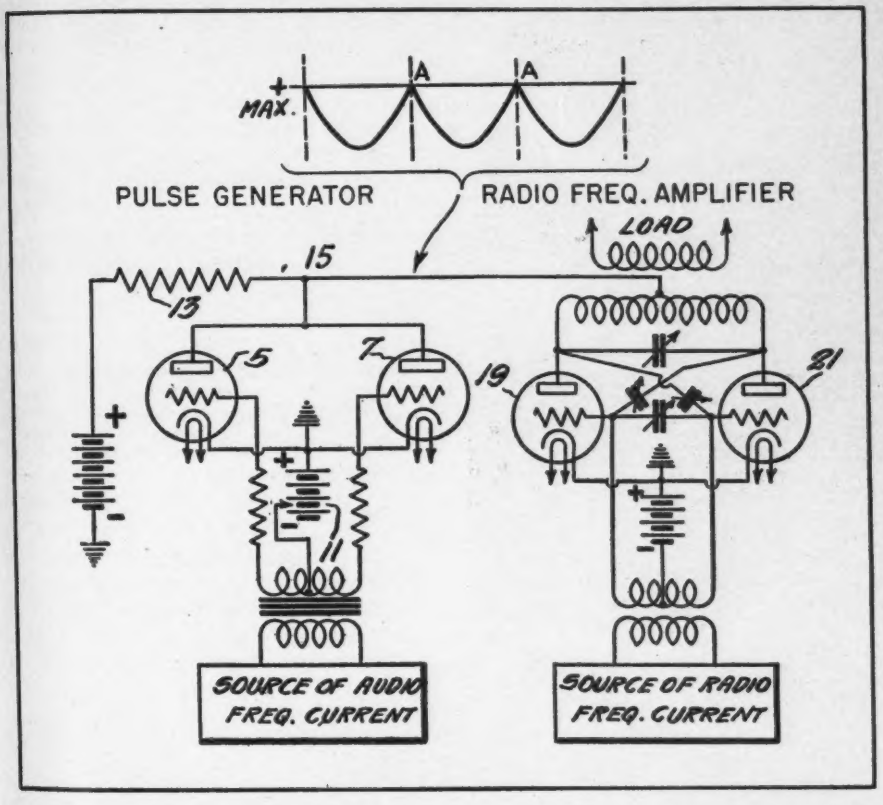
The Ripley Co., Torrington, Conn., has established a New York office at 82 Beaver Street. It will be in charge of Frank Rudolph, vice-president in charge of sales, with S. R. Viejo as sales engineer, handling all products of the combined Ripley organizations.

PATENTS

(*Continued from page* 102)

are biased to cut-off. Alternately the grids are biased positively by the voltage supplied from the audio frequency source and current will flow alternately through tubes 5 and 7, except during very brief and uniformly spaced instants when the audio voltage has zero value. At these instants neither tube will conduct current and the voltage drop across impedance 13 will be a minimum making the plate voltage applied to radio frequency tubes 19 and 21 a maximum. The shape of the voltage at point 15 is indicated in the diagram, the sharp, short peaks, A, occurring at instants of zero audio frequency voltage. During these peaks only, the radio frequency amplifier becomes operative generating pulses of short duration compared to their period, i.e., they may be made as short as ½% of an audio cycle. A suitable circuit for shaping the pulses is also disclosed.

C. W. Hansell and O. E. Dow, RCA (F) March 16, 1938, (I) May 21, 1946, No. 2,400,822.



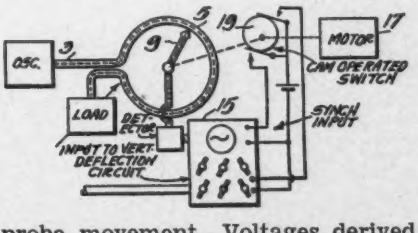
Balanced Modulator

The double-balanced modulator includes a square-wave carrier which is applied alternately to the cathode resistors of the two modulator tubes, cutting them off at alternate intervals. The modulating signal is applied to the grids in push-pull relation. The output from the modulator contains the sum and difference frequencies of the carrier and modulating waves but no component of the original waves nor any harmonics.

H. Toomin, Press Wireless, Inc., (F) September 11, 1943, (I) April 30, 1946, No. 2,399,586.

Standing Wave Ratio Indicator

To measure the standing wave ratio in transmission line 3, the circular shaped transmission line 5 is series connected. Probe 9 rotates in a slot provided in the outer conductor of line 5. Movement of the probe is controlled by motor 17 which, through the action of cam 19, synchronizes the sweep frequency of oscillograph 15 with the probe movement. Voltages derived from the probe are detected and applied to the cathode ray oscillograph which will show a picture of the standing wave. Subdivision of the cathode-ray tube screen facilitates determination of the standing wave ratio from the shape of the voltage curve.



D. W. Peterson, RCA, (F) October 6, 1943, (I) May 21, 1946, No. 2,400,597.

- Easy to install
- Watertight
- Seals Cable Ends

SERVES AS CENTER INSULATOR ON HALF-WAVE DOUBLET

The new B & W CC-50 Connector does an excellent job of providing a waterproof termination for a coaxial line where it joins the center of a half-wave doublet antenna. Made of cast aluminum with steatite insulation and forged steel eyebolt with easy soldering connections. Weighs only 12 ounces. Absolutely watertight. Write for details.

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NEW BOOKS

Metallizing Non-Conductors

Published by the Metal Industry Publishing Co., New York, N. Y.; 62 pages; 5½" x 7½"; paper bound; price $2.

With all of the activity now evident in metallizing insulating plaques for use in "printing" radio circuits instead of wiring up the conductors, and the many other uses for metallizing in industry, this survey of the art serves to call attention to the many methods available for applying metal film on other materials.

The six methods described are: mechanical film, chemical reduction methods, cathode sputtering, metal spraying, metallic paints, and electroplating. Details of numerous processes in each field are given. An extensive reference list is included.

Inductance Calculations

By Frederick W. Grover, Ph.D., Professor of Electrical Engineering, Union College; formerly Consulting Physicist, National Bureau of Standards. Published by D. Van Nostrand Co., Inc., 240 4th Ave., New York; 1946; 286 pages; $5.75.

This extraordinarily complete work on inductance calculations will prove a valuable addition to any design engineer's library. Replete with working formulas and tables, it contains a first-hand discussion of general principles and basic formulas. Latter chapters treat almost every imaginable form of coil in detail, giving the most useful solution formula. Where special factors are required, based on shape or other characteristics of coils, tables rather than curves are given due to their greater exactitude. Truly in this work nothing on mutual or self inductance seems to have been left out.

DuMont-INS Plan Teletype News BC

Allen B. DuMont Laboratories and International News Service planned to start a new sort of news broadcasting service middle of August in which teletype printer bulletins would be viewed by a television camera and broadcast to video screens from WABD. Plan contemplated two hours of news telecasting daily.

BOOK YOUR SPACE NOW

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OCTOBER 14 THRU 19, 1946

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Induction Heating
Intercommunicators
Kits
Laboratory Equipment
Lie Detectors
Marine
Medical Equipment
Metal Locators
Mobile Equipment
Optical Equipment
Police
Power Supplies
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Television
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Tubes
X-Ray

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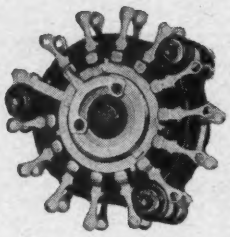
INSTRUMENT & TESTER SWITCHES

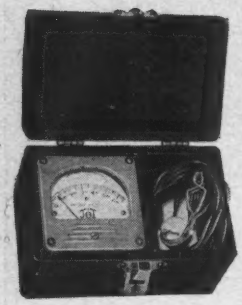
12-14 and 20 position. Shorting; non-shorting 1-6 decks.



(SS-14-2)

OPERATING TEMPERATURE TESTERS

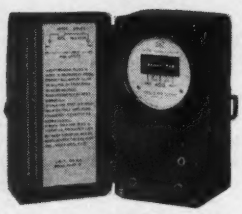
Automatically compensated, typical range for ovens, 0-650°F.



(32-JPI)

400 CYCLE PORTABLES

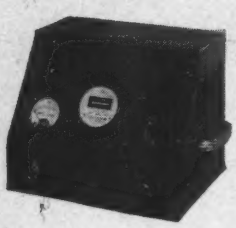
Accuracy to ±0.3%; pocket size metal case; other ranges.



(33-FP9-400 cy.)

VACUUM-TUBE FREQUENCY METERS

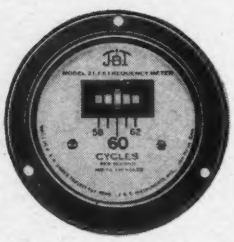
Accuracy, ±0.25%; six specific bands, to 3600 cps. No drift.



(39-VTF)

MOST COMPACT FREQUENCY METERS

Matches standard 2½" panel instruments. 60, 120 cps.



(21-FX-60 cy.)

ELAPSED TIME—FREQUENCY METERS

3¼" mounting; encourages periodic servicing and tube-life checking.

(31-FE)

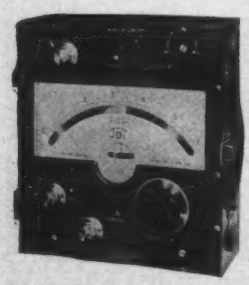
MULTIPLE RANGE PORTABLES

Standard—4 frequency groups at 3 voltages. Many special order variations.

(60-FP)

POTENTIOMETER-PYROMETERS

Measures and follows temperatures continuously after initial balancing.



(70-PO)

BOOTH #101

...many of these, and others from the J-B-T line, are now stocked by leading jobbers.

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PERSONNEL

Edward N. Wendell has been appointed vice-president of Federal Telephone and Radio Co., Newark, N. J. and assumes full managerial authority over this manufacturing affiliate of IT&T. He has served as radio division manager of FTR and as manager of its telephone division.

Edward N. Wendell

A. J. Eaves

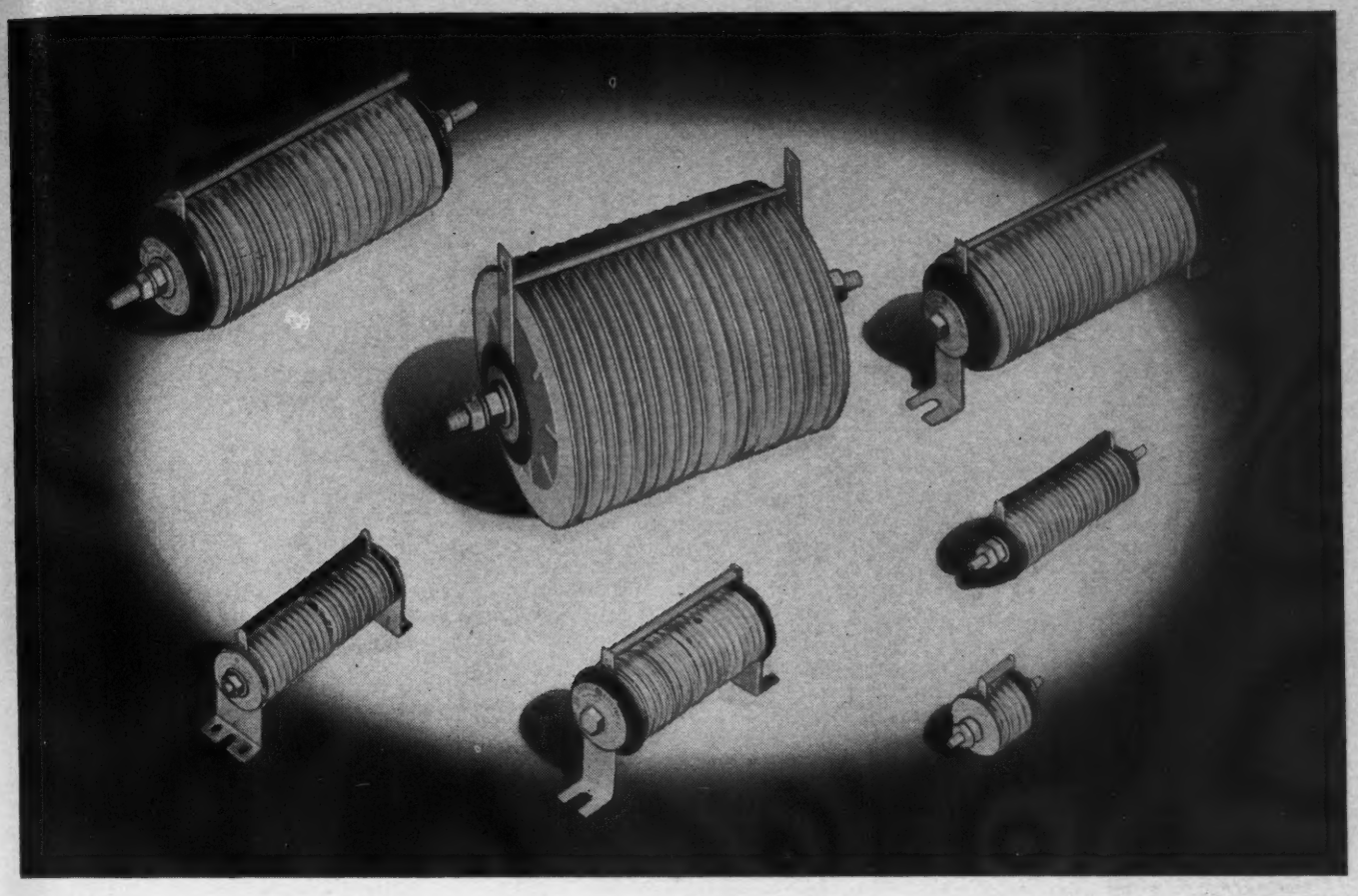
Augustus J. Eaves, formerly development engineer on communications systems for Bell Telephone Laboratories, and for the past 20 years general communications sales manager for Graybar Electric Co., New York, has joined Finch Telecommunications, Inc., New York. He will be director of sales.

Harvey Tullo who recently joined Emerson Radio and Phonograph Corp. as director of purchases has been elected a vice-president of the company. Before joining Emerson he had been with Zenith, Kolster and Pilot.

Ralph P. Glover who recently joined Technology Instrument Corp., Waltham, Mass., will act as liaison between the company's engineering staff and its customers in the Chicago area serving as technical representative there, not as head of the organization's engineering staff as previously reported in error. He will provide technical information to users of the firm's instruments.

Dr. William L. McCracken, recently discharged from the U. S. Army Engineers with the rank of lieutenant colonel has been appointed administrative assistant to C. F. Dinley, Sr., vice president in charge of research and engineering, Detrex Corp., Detroit.

Richard C. Kleinberger has established a consulting engineering practice at 20 Cushman Road, White Plains, N. Y. He will specialize in electronic heating applications.



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You can count on G-E Selenium Rectifiers to give you long, faithful, economical service wherever d-c power is required from an a-c source.

Electrically and mechanically they are built and exclusively processed to give dependable operation in either series, parallel or series-parallel connections. Too, they are constructed to withstand wide variances in ambient temperatures, humidities and atmospheric pressures.

Their small size, light weight and quiet operation plus their ability to resist shock and vibration make them ideal for use in radio and electronic fields, solenoids, relays, motors, instruments and numerous other applications.

For complete details, send for a copy of our catalog entitled, "G-E Selenium Rectifier Stacks." Address your requests to Section A5612-124, Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut.

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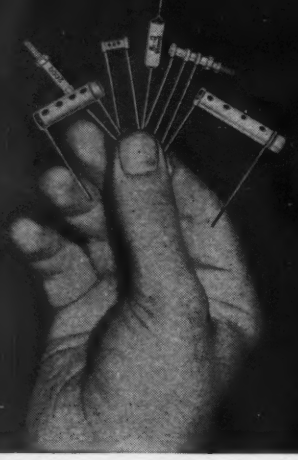
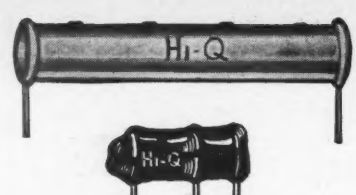
Hi-Q CERAMIC CAPACITORS

EACH TYPE SPECIFICALLY DESIGNED *TO HELP YOU MAKE BETTER PRODUCTS!*

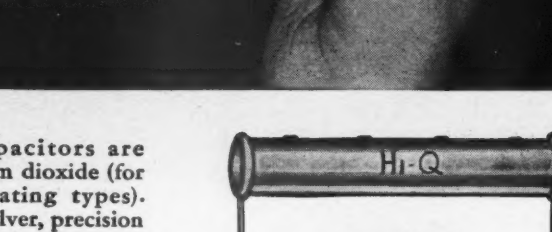


● Hi-Q Ceramic Capacitors are manufactured of titanium dioxide (for temperature compensating types). Electrodes are of pure silver, precision coated. They are individually tested for accuracy of physical dimension, temperature coefficient, power factor and dielectric strength. Available in C. I. type (axial leads) and C. N. type (parallel leads) also Durez coated for fullest protection against extremes of fungus and climatic conditions.

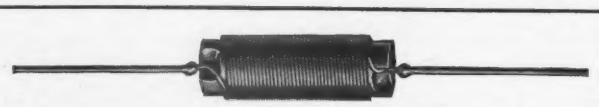


OTHER Hi-Q COMPONENTS

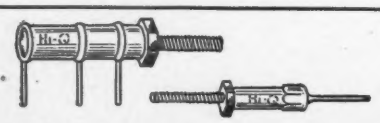
WIRE WOUND RESISTORS



CHOKE COILS



STAND-OFF CONDENSERS



Hi-Q ELECTRICAL REACTANCE CORPORATION
FRANKLINVILLE, N. Y.

L. M. Persons has been appointed research and development director of the electric products division of the McQuay-Norris Mfg. Co., St. Louis. **George F. Platts** has been made general manager of operations of the division.

Theodore K. Bergenbauch has been appointed electronics division production manager of Ellinwood Industries, Los Angeles. Until six months ago he was assistant factory engineer in the electronic tube division of General Electric Co., Schenectady.

Stephen Horbach, who for some time has been a member of the engineering staff of Press Wireless, Inc., has been appointed sales manager of Press Wireless Mfg. Co., a subsidiary. Before joining PW he had spent four years with Army Communications.

Stephen Horbach Lester N. Hatfield

Lester N. Hatfield has been made chief engineer of the Press Wireless Mfg. Co., Long Island City, N. Y. For ten years he was technician and engineer for CBS, before that was chief engineer of station KWSC. He joined Press Wireless in 1945, has been chief sales engineer.

Dr. Royal K. Abbott has been made laboratory director for the General Electric Co., in South America. A member of the Pittsburgh laboratory of GE for the past three years, he left July 15 for Rio de Janeiro, Brazil.

George F. Knowles has joined the design firm of Spectrum Engineers, Inc., Philadelphia as consulting mechanical engineer. During the war he was production manager for Fox Industries, Inc.

Jules Deutsch has been made assistant executive vice-president of Noma Corp., New York. He will have charge of industrial engineering, plant layout and production. Until now, and for the past 15 years, he has been plant manager of the Glolite Corp., Chicago.

Dr. R. O. Curry, acoustical expert, has been appointed audio and acoustical engineer for the Farnsworth Television & Radio Corp., Ft. Wayne, Ind. He previously has been engaged in audio research for the Capehart division of the company.

Dr. R. O. Curry William M. Myers

William M. Myers has been appointed chief engineer of the receiver division of the Farnsworth Television and Radio Corp., Ft. Wayne, Ind. Before joining Farnsworth in 1940 he had been associated with Crosley Corp. for 11 years as an engineer.

Harry E. Rice has been made chief engineer of the home and aircraft radio divisions of Lear, Inc., Grand Rapids, Mich. At the same time, **Harry S. Jones** was made chief engineer in charge of research and development; and **William J. Perfield** was made head of engineering activities for the company's electro-mechanical division.

Thomas B. Aldrich has been appointed general sales and advertising manager of the Presto Recording Corp., 242 West 55th Street, New York. For the past 10 years he has been factory sales engineer in the New York metropolitan area.

LETTERS

Industrial Servicing

Editor, Electronic Industries: The undersigned is a subscriber to your magazine as a help in his business, and finds it very interesting from cover to cover.

In your June issue of 1946—page 4, your Editorial comment titled "Industrial Servicing" was especially noted. It is just with this in mind that the company, of which I am vice-president, was organized in January of this year, when a preliminary survey of the medical and industrial fields showed quite a need for such organization, but no one seemed to want to develop it.

Naturally such organization can be beneficial in more ways than just servicing, hence we organized for sales, servicing, and design where necessary. Servicing has not been profitable, but from the looks of things, will come to its own in the not too distant future.

We feel this kind of organization will be very beneficial, and already we find the industries that were slow in accepting electronics, now do so less reluctantly because we guarantee servicing.—C. R. Maduell, Jr., Delta Electronic Equipment Co., Inc., New Orleans, La.

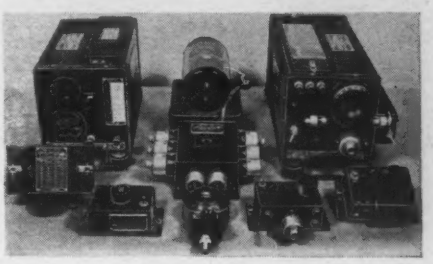
The Middle Course in Engineering Training

Editor, Electronic Industries: Regarding your July editorial, "Theory Versus Handbook Teaching," I am inclined to the thought that most engineering schools nowadays do not follow either the handbook teaching method nor do they stress entirely the teaching of modern mathematical physics. The facts of the matter are that only five to ten per cent of our engineering graduates are in need of highly theoretical training. This small percentage includes the men who are engaged in research work, college teaching, and high-class theoretical design and analysis. The great bulk of the engineering work of the country does not require the more theoretical training.

Our engineering graduates should be trained in the use of their common "tools," English, mathematics, and drawing. They should also be well founded in such "rule" subjects as physics and chemistry. By rule subjects I mean subjects in which basic natural laws are studied. The rest of their time should be given and is given to courses which develop a knowledge of engineering materials and of technical skills because, after all, the prime job of most engineers is to use their technical skills and their tools and follow the basic natural laws or rules to mold from the materials of engineering the engineering structures and products which make the world a better place to live in and make it easier for men to live in it. I would say, therefore, that most universities today follow the middle ground between the two extremes indicated in your editorial.

I have been following Electronic Industries with interest, and I wish to congratulate you on a first class paper.—D. D. Ewing, Head, School of Electrical Engineering, Purdue University, Lafayette, Ind.

U. S. GOVERNMENT SURPLUS



airborne RECEIVER—TRANSMITTER combinations

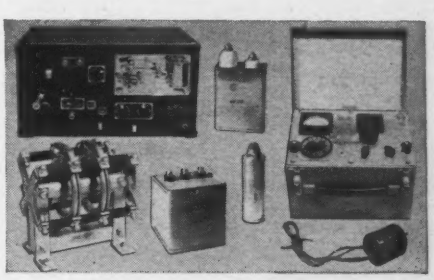
(#RU 16/GF 11)

Over 1,000 units available, including 700 complete sets, plus maintenance spares, spare tubes, spare coil kits, etc. Excellent opportunity to outfit one or more fishing fleets. Can also be adapted in export for marine work.

Frequency Range { Trans.—3,000-9,050 KC; Rec.—195-13,575 KC

Receiver is TRF and can easily be modified for direction-finder operation.

To be sold as one complete lot only. Write or phone for information.



A Warehouse Full of Other U. S. Gov't Surplus Electronic Equipment

Inquiries invited from Jobbers, Distributors, Exporters, Priority Purchasers, etc.

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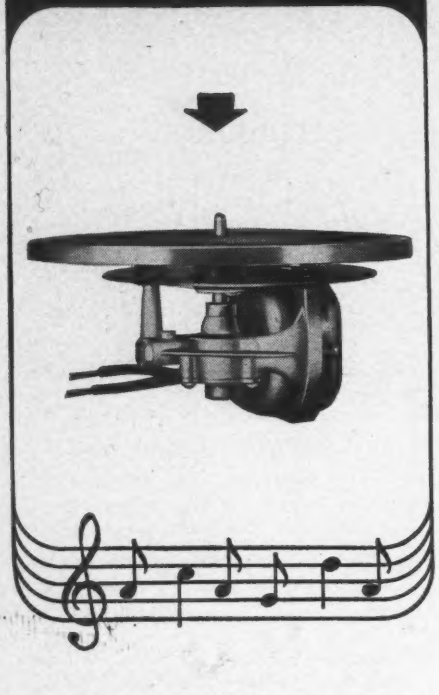
SMOOTH SPEED
with
Smooth Power



You can be sure of unvarying speed for your phonograph mechanisms when you equip them with GI *Smooth Power Motors*. Test any unit from our wide line, in laboratory or in service, and you'll find it runs with accurate uniformity at its rated speed.

But you want other qualities, too, such as quick pickup, quietness and all 'round velvety smoothness of operation. You get all these in GI motors for phonographs, recorders or record-changers.

For Smooth Speed, standardize on Smooth Power.

THE GENERAL INDUSTRIES CO.

DEPT. ML ELYRIA, OHIO

NEW BULLETINS

Time Switches

Time switches in a wide variety of types and for application in any field where accurate control is required are illustrated and described in a new four-page bulletin (T-55) just issued by Automatic Temperature Control Co., Inc., 34 East Logan Street, Philadelphia. The bulletin describes and illustrates operation of six of many types including automatic resetting, continuous repeating, dial setting and a special cut cam type which reverses SPDT switch for one minute every five minutes.

Tube Booklet

Characteristics, ratings, prices and warranties of General Electric transmitting and industrial electron tubes are listed in a new 8-page booklet (ETX-10), prepared by the tube division of the company's Electronics department. Tube types are arranged alphabetically in thirteen sections and listed numerically by type number. Description and rating publication numbers are included in the chart of key information concerning each tube type.

Precision Cleaning

Passaic Analytical Laboratories, Inc., Passaic, N. J., has issued a 6-page booklet on precision cleaning by the Eng-Sol method using a high velocity atomized spray. The method consists of spraying a chlorinated hydro-carbon solvent with heated air. It is applicable to bearings, watch-clock mechanisms and all kinds of small parts of this nature.

Panoramic Scanning

Panoramic scanning of a section of the radio spectrum which came into widespread wartime use, is described in great detail in a new 34-page booklet issued by Panoramic Radio Corp., 250 West 55 Street, New York. The handbook describes the construction, function and operation of model PCA-2 Panadaptor unit which is designed for use with any communications receiver. It is well illustrated with diagrams and sketches showing how to connect the unit, how to adjust it for best operation and the many useful ways in which the principle becomes of practical value in simplifying operating technics. Maintenance and service also are covered.

Radio Components

Three new catalogs have been issued by James Millen Mfg. Co., Malden, Mass., and describe a long line of "designed for application" components and finished products such as frequency standards UHF calibrators, synchroscopes, regulated power supplies and pulse formation equipment. A condensed general catalog covers practically the complete line, with prices. The third catalog is devoted to component parts, variable condensers, insulators, special sockets, chokes, coils, etc., and the line of midget absorption frequency meters.

Split Bearings

A new 30-page catalogue has just been issued by the Split Ballbearing Corp., Lebanon, N. H., giving specifications on sizes, load ratings, etc., on a complete line of divisible race, ball, roller and thrust bearings. Illustrations of actual applications of these bearings in power plants, printing equipment, paper making machinery, rock crushers, etc., are also shown.

These divisible race ball bearings are shown supplementing standard ball and roller bearings, thus eliminating friction type bearings in many applications. They are available in stock sizes from ½ in. to 2½ in. and as specials in other sizes.

Mallory's Fifth

Some 50 pages fatter, fifth edition of Mallory's Radio Service Encyclopedia has appeared, listing replacement recommendations for all prewar receivers. It was almost 13 years ago that the first edition appeared and more than 4½ since the last edition was brought out. Like the previous books, this one, running to 480 pages, lists all receivers and gives data on original component equipment as well as replacement information covering controls, condensers, vibrators, tubes, IF frequencies, and a tie-in with data in Rider's Manuals. Publisher is P. R. Mallory & Co., Inc., Indianapolis, Ind.

Micro Switches

Micro Switch, Freeport, Ill., has issued a new catalog (No. 61) fully describing its complete line and illustrating many of the varied uses for Micro switch products. Listed are many types of housings along with varied types of actuators that make possible the use of these products to make machines automatic, for machine limit and control, to aid in positioning materials, to control electrical current and/or temperatures. This catalog is an excellent handbook for design and production engineers, and will prove helpful to time study men as well.

Resistor Chart

An attractive heavy-paper chart either for filing or for wall use and containing complete engineering details on Akra-Ohm precision fixed wire-wound resistors is being offered by the Shallcross Mfg. Co., Collingdale, Penna. Fifty-four different precision resistor types are illustrated and described. Full details are included on countless adaptations for specific engineering purposes. Dimension data, mounting specifications, minimum and maximum resistance values, tolerance, temperature charts, temperature coefficient data and various other factors are arranged in quick, easy-to-find style.

Laboratory Panels

Standard Electric Time Co., Springfield 2, Mass., has issued a booklet (No. 142) on "Laboratory Panels and Associated Equipment". Section I of the 36 pg. catalog gives a listing of parts for panels and miscellaneous items and describes laboratory precision timers and impulse machines. Section II shows a variety of physics, chemistry and electrical laboratory layouts for high schools, vocational and technical schools. Section III illustrates typical panel and equipment installations in a number of colleges and universities.

Communications Receiver

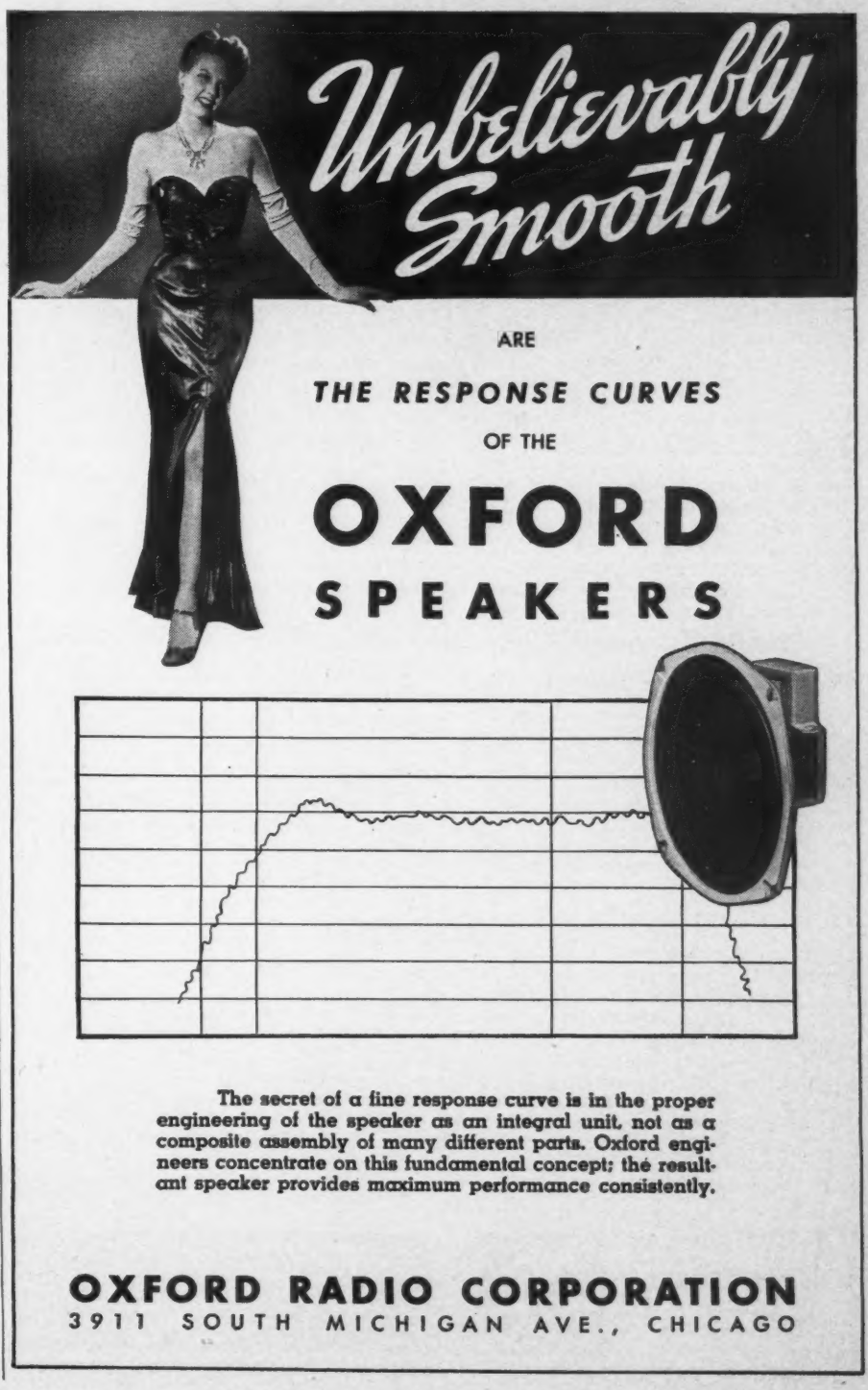
The series 400 Super-Pro communications receiver is described in a folder distributed by Hammarlund Mfg. Co., 460 W. 34th St., New York. Illustrations of components and assemblies are shown and the salient features are listed. A one page insert gives the technical specifications and a circuit diagram of the receiver. Two models are available: SP-400-X covering .54 to 30 mc in five bands and SP-400-SX, with range from 1.25 to 40 mc.

Aircraft Radio Equipment

Bendix Radio, Baltimore, Md., has issued a series of bulletins describing aircraft receivers and transmitters, radio direction finding equipment and vhf antennas. Each folder gives engineering specifications, photographs and dimensional drawings. Included are the RA-1, RA-2D, and RA-10 series aircraft receivers, the TA-2, TA-6 and RTA-1B series transmitters and transceivers and also the MN-26 series manual radio compass, the MN-31 automatic radio compass and the MS-105A vhf broad band antenna.

Rivet Catalog

Milford Rivet and Machine Co., Milford, Conn., has issued catalog No. 45 R on Split semi-tubular and compression valves. The 16 pg. booklet contains price and dimension tables for a variety of types. Several pages are devoted to helpful suggestions and data on proper rivet setting.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The secret of a fine response curve is in the proper engineering of the speaker as an integral unit, not as a composite assembly of many different parts. Oxford engineers concentrate on this fundamental concept; the resultant speaker provides maximum performance consistently.
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A new weapon in your fight to reduce production costs . .

MARION PORTABLE BENCH-TYPE INDUCTION SOLDERING UNIT

A low-cost, low-powered induction soldering unit, designed for use wherever production soldering of small metal parts and assemblies is part of the job. It increases the quality of soldering operations . . . minimizes time and expense involved . . . requires no experienced help . . . and can effect major production economies in such diverse fields as radio, electronics, jewelry, electrical fixtures, toys, kitchenware, motors, paint brush ferrules, can sealing, etc.

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- It increases the speed of soldering operations – and provides a result often impossible with other methods.
- Produces cleaner work and eliminates many cleaning operations.
- Ideal for use with belt-line or turntable types of automatic feed.
- Inexperienced operators can produce uniform results with greater safety to the operator than is afforded by any other means.
- It is cheaper to operate than a solder pot, consuming only 775 watts at full load and only 100 watts on standby. Power is drawn only when soldering is taking place.
- No moving parts to wear out. Tube replacement costs low. All components are designed with generous safety factor.
- The heater offers less hazard than a soldering iron, and yet does a neater, cleaner, faster job . . . without danger of sparking or radio frequency burns.

$360.00 F.O.B. Manchester, N. H.
(Foot Treadle Extra)

Each unit is accompanied by a manual which covers not only operating and service information, but also the design of the work coils for fundamental shapes such as square, rectangular, round and oval.

SPECIFICATIONS

Power Supply: 115 volts, 60 cycle ● **Size:** 15¾" x 21½" x 15" ● **Mounting:** Standard relay rack cabinet ● **Weight:** 150 pounds ● **Power Consumption:** 775 watts at full power output, 100 watts standby.

The entire unit is rigidly assembled and mounted to prevent arc-over and failure of components.

FIND OUT

Find out, without obligation, what the Marion Induction Soldering Unit can do for you. Forward your specifications and sample parts for analysis and soldering. A complete analysis will be made and recommendations will be returned to you within one week.

MARION ELECTRICAL INSTRUMENT CO.
MANCHESTER, NEW HAMPSHIRE
EXPORT DIVISION: 458 BROADWAY, NEW YORK 13, N. Y., U. S. A. CABLES, MORHANEX

IN CANADA: THE ASTRAL ELECTRIC COMPANY, SCARBORO BLUFFS, ONTARIO

Powdered Iron Cores

A new descriptive booklet on powdered iron cores and their uses has been issued by Henry L. Crowley & Co., Inc., West Orange, N. J. In addition to a technical explanatory section in the front, a large number of charts are included showing effective permeability-frequency relations for the various powder and binder combinations maintained as standard.

Sections are devoted to effect of addition of adjusting screws, uses of copper cores and to a new low cost core called "croloy". Detailed outline drawings of a large number of stock sizes of cores are included.

Recording Discs

Audio Devices, Inc., 444 Madison Ave., New York, has issued a 24-page brochure that presents its five types of recording discs. In addition there is much technical data of a practical nature concerning proper cutting methods and the reason for faults that develop. There is also a section devoted to the company's line of recording styli and playback points.

Die-Less Publication

O'Neil-Irwin Mfg. Co., Minneapolis 15, Minn., has published a catalog (No. 46-10) summarizing developments in the Di-Acro system of forming without dies. Complete descriptions and illustrations of benders, brakes and shears as well as an unusual application of two benders being operated simultaneously are included. The flexibility of the machines makes them suitable for model shops, experimental laboratories and production departments.

Radio Reception Equipment

A series of four bulletins containing two new additions to the line has been published by Radio Mfg. Engineers, Inc., Peoria 6, Ill. One covers the RME 84, a new 8-tube communications receiver with a frequency coverage from .54 to 44 mc. The new VHF-152 converter for the 2, 6, and 10 meter amateur bands is described in another bulletin. The converter uses minature tubes in a double conversion system. The revised DB 20 preselector, which has a tuning range from .55 to 33 mc, and the RME-45 communications receiver are covered in the remaining two bulletins.

Retaining Rings

Technical Data concerning varied applications of 7 basic retaining ring types are contained in a 48 pg. catalog distributed by Waldes Kohinoor Inc., Long Island City 1, N. Y. Of interest to engineers and product designers the catalog includes comparative charts on material characteristics, critical dimensions, thrust loads and impact tests. A reference table gives correct retaining ring size and number for commonly used ball bearings.

Photo-Electric Devices

A folder describing a number of photo-electric devices is available from Worner Electronic Devices, 609 West Lake St., Chicago 6, Ill. Features and applications are listed for a general purpose unit, the "Anti-Sabotage Sentinel" and the "Combustion Supervisor" control.

Lighting Controls

Electronic control of theatre lighting systems is described in Bulletin 74, issued by Ward Leonard Electric Co., Mount Vernon, N. Y. Included are various types of control consoles and panels for use with the Ward Leonard Hyster-set system of reactance dimmer switchboards for smooth, pre-set programming of lighting effects.

RF Thermocouples

American Thermo-Electric Co., 67 E. 8th St., New York, has issued a 10 pg. booklet describing their complete line of vacuum thermocouples for the measurement of low and high frequency ac power. Data on heater current, dc thermojunction voltage and heater resistance is supplied for 86 different types of vacuum thermocouples suitable for use at frequencies from 0 to over 50 mc.

Cacpacitor Catalog

Sprague Products Co., North Adams, Mass., has issued a 40 pg. catalog—the first in five years—listing their complete line of capacitors, resistors, filters and test instruments. Photographs, dimensional drawings and tables of electrical specifications illustrate the descriptions of standard and newly developed types. A large part of the booklet is devoted to a listing of dry electrolytic, paper, oil transmitting, mica and miscellaneous capacitors. Also described are the line of Koolohm resistors, interference filters and mounting hardware. The back page is devoted to the Tel-Ohmike resistance and capacitance analyzer. A separate price schedule is enclosed.

Square Loop Antenna

An 8-bay square loop antenna providing a power gain of 9 is described in a 16 pg. booklet available from Federal Telephone and Radio Corp., Newark 1, N. J. The advantages of the antenna are explained and transmission feed line arrangements and constructional details are discussed in detail. Included are charts of power gain vs. loop separation, radiation pattern diagrams and a table listing electrical and mechanical specifications for 1 to 8-bay antennas.

Plastics

The Plastics Div. of General Electric Chemical Dept. has issued a beautifully illustrated, colored brochure summarizing the progress in design, moldmaking and manufacturing technics of plastics. In twenty pages a review is presented of the phases plastic materials undergo from their earliest conception as a research project, through the development, design, moldmaking and manufacturing stages. Typical finished products made by compression, injection and low pressure molding as well as laminated materials are shown.

Controls

Bulletin A-1, for the IRC, catalog is available from International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Type H Fingertip controls, with the resistance element molded in the control knob, are described and a taper chart and dimensional sketch is included. The back of the bulletin covers type SH Fingertip switch. The compact components are designed for mounting on an insulating bracket or panel.

Selenium Rectifiers

Federal Telephone and Radio Corp., Newark 1, N. J., has issued a bulletin explaining the use of a miniature selenium rectifier to replace high vacuum rectifier tubes in ac-dc and console radio receivers. The bulletin gives a number of suggested applications and circuits ranging from half wave to full wave bridge circuits. A chart comparing the regulation of the selenium stack with the 25Z6 tube is included.

TUBES! TRANSFORMERS! CONDENSERS!

NEW CATHODE RAY TUBES!!

Made by North American Philips

Type	Approx. List	Your Cost
2AP1	6.25	3.95
3BP1	15.00	3.95
3FP7	27.00	5.35
5BP1	20.00	4.95
5BP4	27.00	5.95
5CP1	48.00	4.95
5CP7	45.00	6.00
5FP4	32.00	6.25
5FP7	35.00	6.00
5JP1	50.00	13.50
5JP2	48.00	13.50
5LP1	41.00	8.00
5JP4	40.00	8.95
Also: 813	37.00	10.00
723a/b Klystron	38.00	7.75

We have many of these tubes in Manufacturers quantities. Inquire.

PARTS AND COMPONENTS

IF crystal filter, for BC-312, complete with crystal and IF circuit, resonant at 470KC. Sells for the low price of .... $ 9.95

Cardwell Transmitting Condenser type TC-300-US. Maximum capacitance 300 mmf. 2 in. spacing between plates list 40.50. Our Price ..... $ 9.85

BC-603 FM receiver. 85 per cent complete, less tubes front panel and tuning condensers. With complete instruction book and cabinet ..... $ 5.25

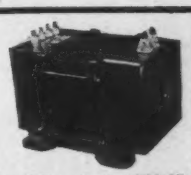
Modulation transformer: 811's to an 8.13. $ 5.00
Driver transformer: 6V6 to a pair of 811's $ 3.00

HI-VOLT plate transformer: ½ wave rectification 115v-60c/3200v @ 150 mils. Made by Kenyon 9.95

HOOK-UP WIRE. From 16 to 22 gauge glass braid covered. $1.00 per hundred feet. min. order ..... $ 1.00

SILVER BUTTON MICA CONDENSERS. stud. mtg. (Erie/Centralab.) 175-180-185-245-335-360-370 mmfd 400vdc
each ..... $ .05
lots of 100 ..... 4.50
lots of 1000 ..... 37.50
minimum order $1.00

HI-VOLT plate transformer, made by Amertran. 115v-60 cycle input. Secondary is 6200v-ct-700 m.a. There is also a tap at 2850 volts.



Specially priced at $39.95

CONDENSERS

6 mfd 600 vdc..	1.35	.4 mfd 1500 vdc	.20
8 mfd 600 vdc..	1.75	.1-.1 mfd 7000	5.00
.05 mfd 1000 vdc	.35	2. mfd 220 va.c.	.75

Oscilloscope Transformer, Ideal for 7 inch tubes. 9000 volts @ 10 ma. This unit, list for $25.50 is..... $11.95

C-D Condenser Special. 4000 mfd @ 30 vdc. Listed at $13.50 released for .... $ 3.40

Deflection and focussing coils for the 5FP7. These coils are being used by all large manufacturers in their latest types of television sets. One set of coils ..... $ 7.95

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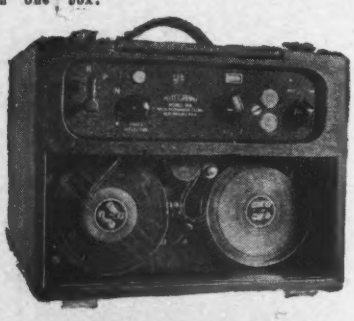
LEADS AGAIN
DECADE BOX

The model OP-113 Decade Box is an instrument designed to service by substitution any condenser in a radio receiver from .0001 mfd mica unit or a 40 mfd filter unit. There are 82 individual mica and oil filled paper condensers arranged in 13 isolated net works, non-interlocking, permitting servicing of from one to 13 condensers at the same time. No electrolytic condensers have been used in this instrument thus, no need to observe polarity when making tests. A whole shop full of condensers in one box.

$ 99.50



FILMGRAPH

Filmgraph, a sound device for recording and reproducing sound on film instantaneously and at low cost.
Filmgraph recordings are reproduced with high fidelity and in volume from a whisper to tones loud enough to fill an auditorium. The sound track is indented, not cut, into the film and the recording may be played back instantaneously without treatment or processing of any kind.
Filmgraph is a complete portable recorder and reproducer equipped with amplifier, speaker, microphone, cables, and controls. Filmgraph can also be used as a public address system. Designed to operate on 110 Volts at 60 cycles AC or from any other current by using a suitable converter or step down transformer.

$ 400. and up

TERMS: 10% DEPOSIT WITH ORDER—BALANCE C. O. D.

LIBERTY SALES CO., INC.
115 WEST BROADWAY · NEW YORK 13, N. Y.

Finch Tests Airborn Facsimile Transmission

The first attempt at publicly demonstrating airborne reception of facsimile transmission, staged middle of July by Finch Telecommunications, Inc., and Capital Airlines, didn't quite make it, though the failure was no fault of Finch's. It was the weather man's. Arrangements had been made to fly Finch

Capt. W. G. H. Finch (left) president of Finch Telecommunications, Inc., and Richard E. Fell, vice-president of Capital Airliines, at first airborne facsimile demonstration

equipment in a four-motored ship out of Newark airport for the reception of transmission from the Finch FM station WGHF in New York. But CAA would not permit the ship off the ground. Nevertheless, the test went on with the ship on the runway and was successful in every respect despite the absence of altitude at which the receiving antenna was strung under the belly of the ship. Plan is for Capital Airlines to use the equipment during regular flights for the reception of in-flight bulletins both for the guidance of pilots and, through reception of news bulletins, etc., for the edification of passengers. WGHF already is regularly broadcasting "Airpress" on 99.7 mc, plans to expand the service.

ISE to Distribute Times Fax Equipment

Telephoto and facsimile equipment manufactured by Times Telephoto Equipment, Inc., New York, is to be distributed in foreign countries by International Standard Electric Corp., world-wide manufacturing and sales organization of International Telephone and Telegraph Corp. ISE is set up to handle sales and distribution of electronic equipment in some 75 countries.

Silver Polishing Without Burnishing

The accidental use of a silver plated wire in cleaning phosphor bronze electrolytically has given birth to a new polishing process that may revolutionize the silver industry. Credit for developing the method goes to Dennis R. Turner, youthful physicist in the electronics department of the Research Laboratories of the Westinghouse Electric Corp.

Profitable accident

Turner had added cyanide to an electro-cleaning solution when dime-size phosphor bronze diaphragms for microwave tubes proved particularly difficult to wash. One of the diaphragms had been suspended in the bath, through which alternating current was passing, by a strand of wire previously used to immerse some object being silver plated. The wire was a dull white in appearance as silver plate always is before being polished. But when the phosphor bronze diaphragm was lifted out of the solution the piece of wire had taken on a high luster.

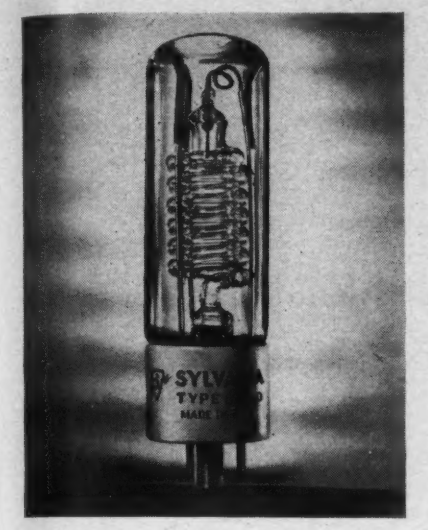
Metal articles to be silver plated are immersed in a bath of silver cyanide plating solution and negative current sent through, causing a deposit of pure silver upon the objects. When they are removed from the bath, they are evenly plated with silver but are white and lusterless. They must be buffed by hand on a revolving wheel treated with some sort of buffing compound to impart the necessary shine. Buffing not only entails an extra handling of every piece but the loss of a certain proportion of the silver through abrasion.

New method

With the new method, the silver plated object is immersed in a bath of silver cyanide solution normal to the regular plating operation. Instead of sending negative current through the bath as in plating, however, positive current is applied in about four times the amperage used to plate the metal, but not continuously. The positive energy is applied for a few seconds, discontinued, then sent through again, and this intermittent action repeated for several cycles. When the article has reached its peak of luster, it is taken out of the bath, rinsed, and dried. The entire operation takes little more than a minute.

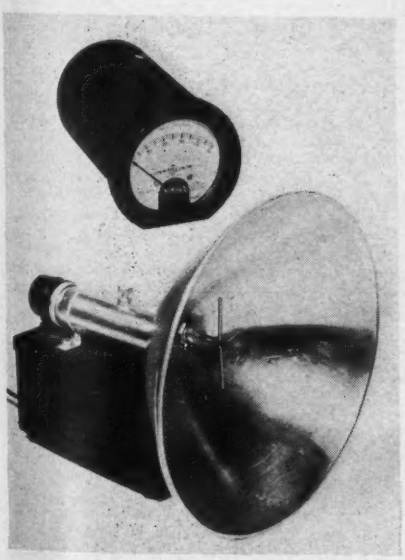
ELECTRONIC PRODUCTS

(*Continued from page* 110)



Flash Tube

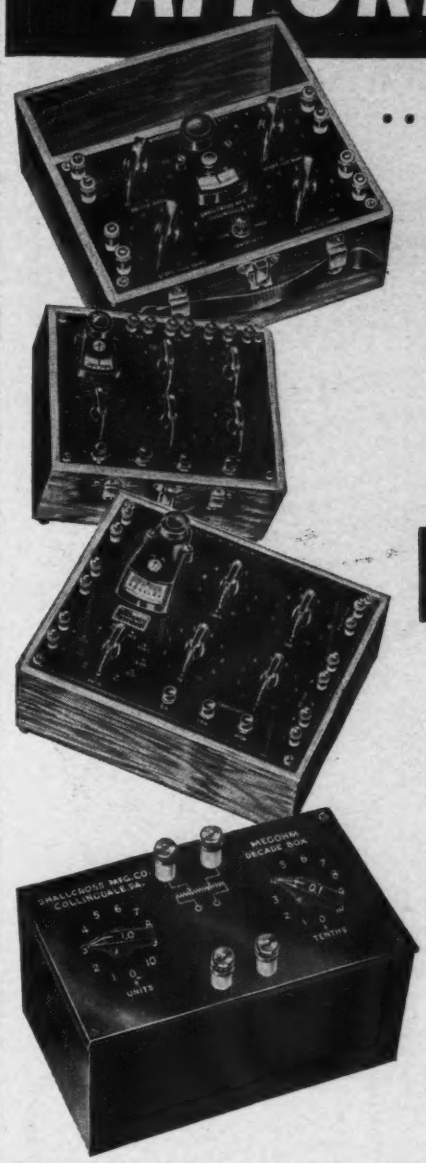
A xenon gas discharge flash tube, which provides flashes of 1/5000 second duration with a peak light output of 12 million lumens for photographic, airport and signaling applications is being manufactured by Electronics Div., Sylvania Electric Prods., 500 Fifth Ave., New York 18. The tube may be operated in a condenser discharge circuit and has an average rated life above 10,000 flashes.—Electronic Industries



Microwave Equipment

New lightweight microwave equipment, including an oscillator and hand intensity meter for a study of electromagnetic radiations at an ultra-high frequency, has been developed by the Specialty Division of General Electric Company's Electronics Department at Syracuse, N. Y. Designed for schools and radio instructors as a part of the Division's electronic educational line, the equipment weighs only 4 lb. It operates on a frequency of about 2400 mc. Using a "lighthouse" tube, the oscillator cavity is mounted directly on a small case containing a transformer and attenuator, and bears a dipole antenna and 8-in. reflector. Completely self-contained and portable, it operates directly from 110 volt, 60 cycle alternate-current. The intensity meter consists of a crystal detector and microammeter.—Electronic Industries

INSTRUMENTS YOU CAN AFFORD TO USE



...on everyday jobs

INEXPENSIVE

ACCURATE

RUGGED

EASILY REPAIRED IN CASE OF MISUSE

Hundreds of production line testing jobs and field investigations, in addition to laboratory tests require dependable instruments of a type that don't have to be kept under lock and key because of their extreme delicacy and high cost. Shallcross answers this need with many types of

BRIDGES — DECADE BOXES
RESISTANCE STANDARDS
DECADE POTENTIOMETERS
HIGH-VOLTAGE TEST EQUIPMENT, etc.

These instruments are accurate for every commercial and laboratory need up to the point of the most exacting research in pure physics. They are rugged, easy to operate and decidedly moderate in price. In case of misuse, they can quickly be repaired to full efficiency by any reasonably competent individual without the expense and delay of returning them to the factory.

WRITE FOR BULLETINS

Bulletin 810, Shallcross Resistance Standards
Bulletin 825, Resistance Decades
Bulletin D-1, Bridges
Bulletin LRT, Low Resistance Test Sets
Bulletin G, Electrical Measuring Apparatus for schools and colleges

SHALLCROSS MFG. CO., DEPT. EI-96. Collingdale, Pa.

SHALLCROSS Electrical Measuring Apparatus • AKRA-OHM Resistors • Precision Switches • Electronic Engineering

BRILLIANT PERFORMANCE

that never grows dim

TURNER
MODEL 211
DYNAMIC MICROPHONE

Designed and engineered for the user who wants finest reproduction under a variety of conditions, the Turner 211 Dynamic is the answer to the demand for a high fidelity yet highly rugged microphone.

Turner engineers utilize an improved magnet structure and acoustic network to extend the high frequency range and raise the extreme lows. A specially designed precision diaphragm results in unusually low harmonic and phase distortion without sacrifice of high output level.

Field tested under the most difficult operating conditions, the Turner 211 Dynamic is not affected by temperature or climate. Its response remains free from peaks or holes from 30 to 10,000 cycles. Adapted to both voice and music pickups, the Turner 211 is the ideal companion for quality recording, sound system, public address and broadcast equipment.

Ask your dealer or write

THE TURNER COMPANY

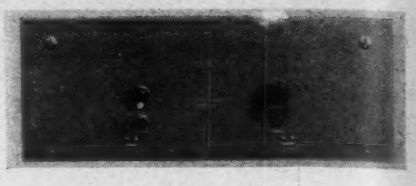
904 17th Street N. E., Cedar Rapids, Iowa

SPECIFICATIONS

- Output Level: −54DB at high impedance (1 volt/dyne/sq. cm).
- Frequency Response: Flat within ±5DB from 30-10,000 cycles.
- Impedance: 30-50 ohms, 200 ohms, 500 ohms, or high impedance.
- Case: Salt-shaker type, chrome satin finish, 90° tilting head.
- Cable: 20 ft. heavy duty with removable type connectors.
- Uni-directional
- Mounting: 5-27 thread (Standard Thread).

TURN TO TURNER FOR THE FINEST IN ELECTRONIC EQUIPMENT

Licensed under U. S. Patents of the American Telephone and Telegraph Company, and Western Electric Company, Incorporated.



VHF Aircraft Receiver

A single channel, crystal controlled vhf receiver for airline communications and traffic control which may be set up for any frequency in the 108 to 132 mc band, has been developed by Federal Telephone and Radio Corp., Newark, N. J. The receiver has a superheterodyne circuit with adjustable level squelch and has a selectivity characteristic permitting 100 kc channel spacing.—Electronic Industries

Multicellular Speaker

Altec Lansing Corp., 250 W. 57th St., New York (19), has brought out the first of a new series of loudspeakers—model 603 multicell Diacone. The unit, which is of the permanent magnet type, has the properties of a 2-way multicellular speaker system, consisting of a metal hf diaphragm and a low frequency cone coupled by a mechanical dividing network and driven by a 3 in. voice coil wound of aluminum ribbon.—Electronic Industries

Personal Aircraft Radio

The Skyfone model CA-2 a light-weight radiophone designed for personal aircraft is in production at Hallicrafters Co., 48 East Ohio St., Chicago 11, Ill. Weighing less than 8 lbs. the Skyfone covers the radio range frequencies, control tower frequencies and beacons for navigational purposes, and includes a broadcast band. The receiver is designed to withstand a wide range of temperatures, humidity and vibration.—Electronic Industries

THERE'S A **DRAKE SOLDERING IRON** FOR EVERY TYPE OF ELECTRONIC WORK

From that mighty mite

the Drake No. 400 to the high speed production "honey"

the Drake No. 600-10 there is a high quality Drake Soldering Iron "just right" for the job.

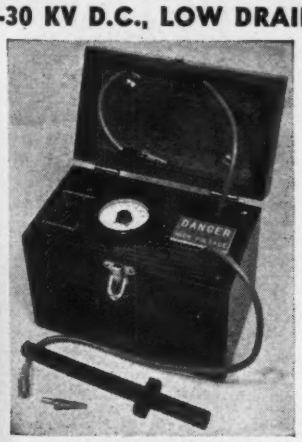
●

Drake Heat Controls and the Drake "Magic Cup" Stand are important soldering aids.

SEE YOUR RADIO PARTS JOBBER

DRAKE ELECTRIC WORKS, INC.
3656 LINCOLN AVE. CHICAGO, ILL.

A NEW KILOVOLTMETER 0-30 KV D.C., LOW DRAIN



Model 101

For use in:

● Television ● Electrostatic Precipitation ● Geiger-Meuller Counters

and all circuits requiring a low drain, high voltage meter.

SAFE: 10" handle permits measurements on live circuits.

SENSITIVE: 20μa full scale. Less than 1μa/KV.

STABLE: Resistor encased in newly developed non-hygroscopic compound.

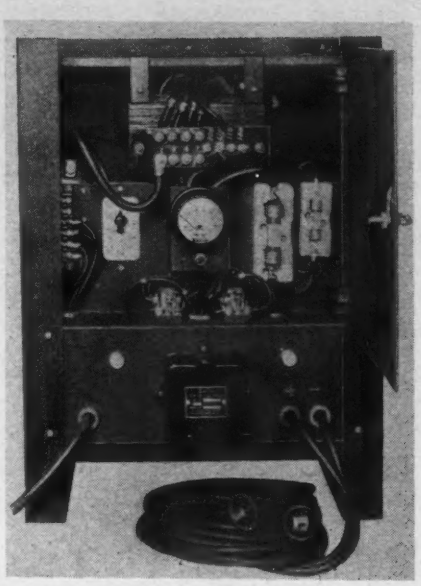
RUGGED: Switch shorts meter in transit.

COMPACT: 11" x 5" x 7".

LOW COST: $59.00.

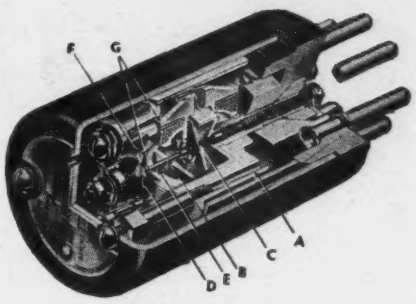
Write for descriptive literature

BETA ELECTRONICS CO.
1762 THIRD AVE. NEW YORK 29, N. Y.
Manufacturers of KV meters; Portable 0-30 KV power supplies; Electronic Microammeters



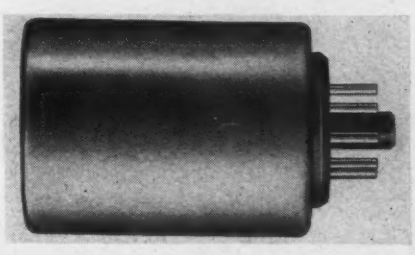
Battery Charger

An automatic two-rate industrial truck battery charger for either lead-acid or Edison type batteries has been designed by Federal Telephone and Radio Corp., Newark, N. J. The unit will charge six-cell, 250 ampere-hour, lead-acid batteries to capacity in 8 hours and ten-cell, 250 ampere-hour Edison batteries in 7 hours. It operates on 105-125 volt, 60 cycle, single phase ac.—Electronic Industries



Low Current Relay

For operation on currents of thermocouple and photocell magnitudes where compactness, light weight and vibration stability are important, a Sensitive Relay (Model 103) has been developed by the Instrument Div., Thomas A. Edison, Inc., West Orange, N. J. The relay design is based on an inversion of the d'Arsonval galvanometer type meter movement, where the permanent magnet swings and the coils are stationary.—Electronic Industries



Microphone Transformer

Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles, Cal., has a plug-in type microphone transformer interchangeable for high or low impedance inputs for use on their amplifiers. Use of long lines and better frequency response regardless of cable length are made feasible by the triple alloy shielded units.—Electronic Industries

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6200 Volt CT—700 Mils, 110 Volts 60 Cycles tapped primary 2 KVA Amertran. Limited Quantity. **$39.95**

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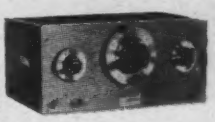
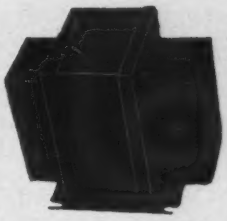
Frequency range 20 cycles to 20,000 cycles in 3 ranges. A Precision Laboratory Instrument. Complete with tubes and power supply, reconditioned and guaranteed by Niagara. Special **$75.00**





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Langevin Swinging Choke—9/60 henries 400/50 mils. DC resistance 72 ohms **$12.75**

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12 Volt dynamotor 235 Volts out at 90 mils. Complete with filter mounted in can 6¼ x 5¾ x 3½" with cover **$2.95**

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Plate transformer 1450 volts CT at 420 mils built by **Kenyon**..$7.95 ea. or two for **$15.00**

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11 position switch, 4 deck low loss, bakelite. **$1.25**

Zero center microammeter 100 microamp each side Black dial 2½"—radium numbers. A good buy at **$3.95**

110 Volt relay AC coil allied **DPDT.** Contacts will handle 10 amps.....**$1.65**

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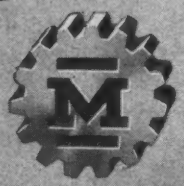

Application

90900 Series
Cathode Ray Oscilloscopes

The No. 90902 and No. 90903 Rack Panel (3½") Oscilloscopes, for two and three inch tubes, respectively, are inexpensive *basic units* comprising power supply, brilliancy and centering controls, safety features, magnetic shielding, switches, etc. As a transmitter monitor, no additional equipment or accessories are required. The well-known trapezoidal monitoring patterns are secured by feeding modulated carrier voltage from a pick up loop directly to vertical plates of the cathode ray tube and audio modulating voltage to horizontal plates. By the addition of such units as sweeps, pulse generators, amplifiers, servo sweeps, etc., all of which can be conveniently and neatly constructed on companion rack panels, the original basic 'scope unit may be expanded to serve any conceivable application.

JAMES MILLEN
MFG. CO., INC.

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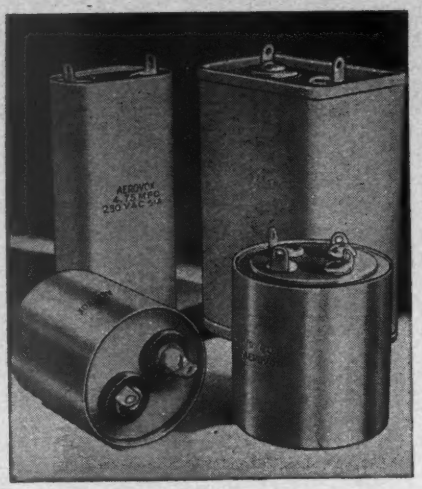
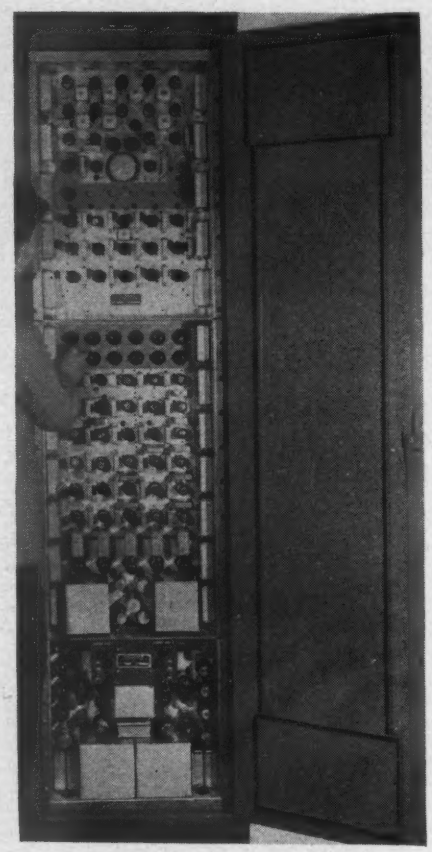


Capacitors for Fluorescents

Extra-rugged capacitors for fluorescent lighting service available to all standard types have been brought out by Aerovox Corp., New Bedford, Mass. The units are impregnated with Hyvol, a synthetic high-dielectric compound with very stable characteristics. The containers are made of heavy steel, plated for protection.—Electronic Industries



Synchronizing Generator

A synchronizing generator (Model PT 101) for television receiver production testing and similar applications is available from Polarad Electronics Co., 135 Liberty St., New York. The unit provides 525 line, interlaced, 60 fields, 30 frames, RMA synchronizing pulses held to the required tolerances. The generator is complete with a 3 in. oscilloscope and a dual regulated power supply in one rack and operates from a 115 volt 50-60 cycle ac power source.—Electronic Industries

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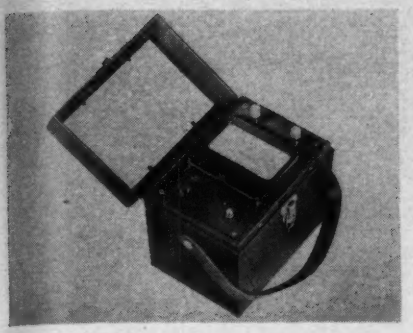
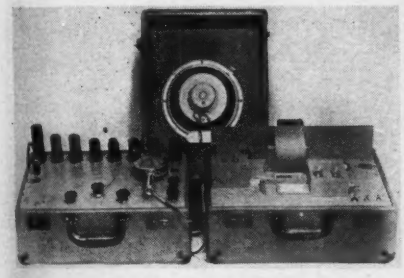


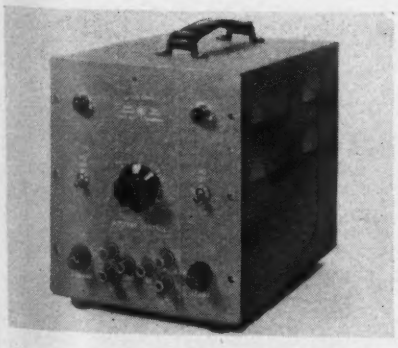
Insulation Resistance Meter

Insulation resistance may be checked to 50,000 megohms by use of the portable self-contained Model 261 vibrotest brought out by Associated Research, 231 So. Green St., Chicago 7, Ill. A test voltage of 500 is provided by two dry-cells and a charging circuit speeds testing of capacity circuits. The unit is designed to withstand temperatures from —40°F to +140°F.—Electronic Industries



Warble Tone Oscillator

Sound Apparatus Co., 233 Broadway, New York 7, has developed an electronic warble tone oscillator designed for use in connection with power level and automatic frequency response recorders for electro-acoustical, speaker and microphone measurements. The equipment includes a speaker, microphone and associated preamplifier, built into a portable case.—Electronic Industries



Laboratory Power Supply

Model 710A regulated power supply, manufactured by Hewlett-Packard Co., Palo Alto, Calif., is a small, light-weight (18-lb.) source of regulated voltage for general laboratory and production use. Output is continuously variable from 180 to 360 volts, and will remain constant to within 1% for loads of from 0 to 75 ma., and for line voltage changes of ±10%. Total noise and hum is less than 0.005 volts. Either positive or negative output terminal may be grounded and the unit also provides 6.3 volts ac, center tapped. —Electronic Industries

● The Webster Electric line of cartridges offers a complete selection to meet the requirements of your present day designs, for you are able to select a cartridge with your requirements for all of the above characteristics.

Webster Electric Cartridges are carefully designed and manufactured under highest quality standards. They have been on the market for years, and during this time have proved their value for long life and top performance.

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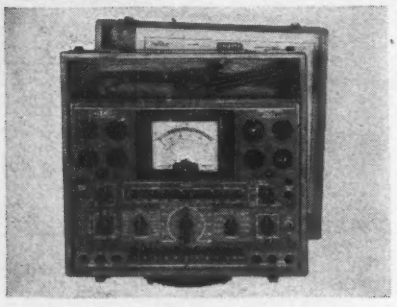
ALL IN ONE PACKAGE

You've got a lot of "sharp" instruments in a small space when you buy the Jackson Model 637. In addition to complete tube testing, it combines 9 functions and 27 ranges, readily selected by push buttons that save time and guesswork.



MODEL 637 DYNAMIC OUTPUT TUBE TESTER

with complete universal meter ranges

1—Dynamic Output Tube Tester—accurate, thorough. **2**—Ballast Tube Tester—finds shorts or burn-outs. **3**—High-sensitivity Neon Continuity Tester. **4**—Condenser Tester for finding shorted or leaky condensers. **5**—Multi-range A.C. Voltmeter: 0-10/100/250/500/-1000/2500. **6**—Multi-range D.C. Voltmeter: 0-10/100/250/500/1000/2500. **7**—Decibel Meter—Ranges from minus 10 to plus 14/10 to 34/30 to 54. **8**—Multi-range D.C. Milliammeter 0-1/10/100/250. **9**—Ammeter Range—0 to 10 amperes D.C. **10**—Triple Range Ohmmeter 0-3000/300,000/0-30 megohms.

Automatic Push Button Selector—permits instant use of any range. Remarkably fast; reduces chance of mistakes.

Full Range Filament Selection—from ¾ V. up to and including 115 V . . . Filament selector marked directly in volts at each position.

Tests All Tubes—all of the popular receiving types and television amplifiers, including Bantams — Miniatures —Loctals — Single Ended — and High-Voltage Filament Types. Provision for many more. Two spare socket positions are provided on panel.

"Dynamic" Method of Test is more accurate, frequently finds "poor" tubes which might pass for "good" in ordinary testers.

New High-Voltage Power Supply—permits using higher plate voltages (over 200 V. for some types), giving more accurate results.

Most Improved Type of Switching System—Spare circuits and switch positions are provided for future use on different tubes.

Controls Easy to Use—You don't waste time figuring out the next move.

Illuminated Meter Dial easy to read. Noise test jacks provided. Dimensions: 14¾" x 13¾" x 6". Weight 14 pounds.

Accessories—Complete with self-contained battery (for ohmmeter), and test prods.

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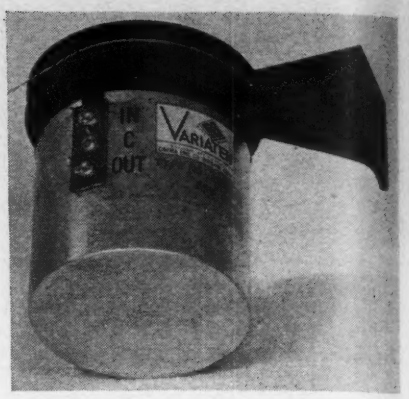
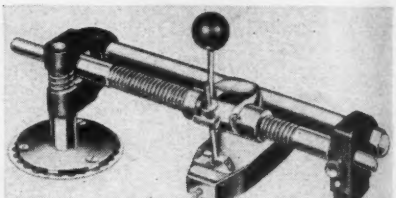
Fine Electrical Testing Instruments

JACKSON ELECTRICAL INSTRUMENT COMPANY, DAYTON, OHIO



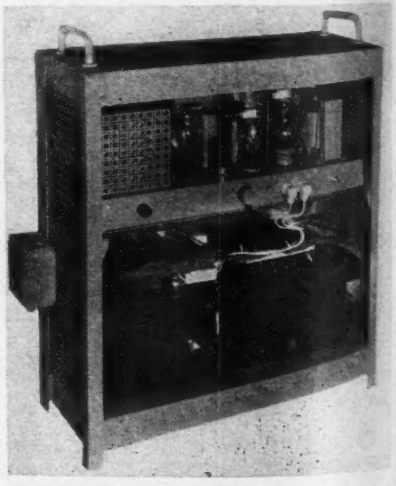
Equalizer

A diameter equalizer capable of equalizing 8 db at 5 in. disc diameter to zero db at 12 in. diameter at 10,000 cycles is in production at Cinema Engineering Co., 1510 W. Verdugo Road, Burbank, Cal. Type 3991 is adjusted automatically as the cutting head moves across the recording disk. The unit has an impedance of 500 ohms and insertion loss is 10 db.—Electronic Industries



Recording Mechanism

A low-cost instantaneous recording mechanism has been brought out by Techno-Craft Prods., 200 Hudson St., New York 13. The unit is provided with cutting needle angle adjustment and has a cutting pitch of 110 lines per in., outside-in. A 12 in. and a 16 in. model are available and any one of four Astatic cutting heads can be furnished.—Electronic Industries



Line Voltage Regulator

The model 5000-2 electronic voltage regulator developed by Sorenson & Co., 375 Fairfield Ave., Stamford, Conn., is designed for 230-volt applications within a load range from 500 VA to 5 KVA. The unit is unaffected by lagging power factor variations or frequency changes between 50 and 70 cycles and has a harmonic distortion of less than 5% total.—Electronic Industries

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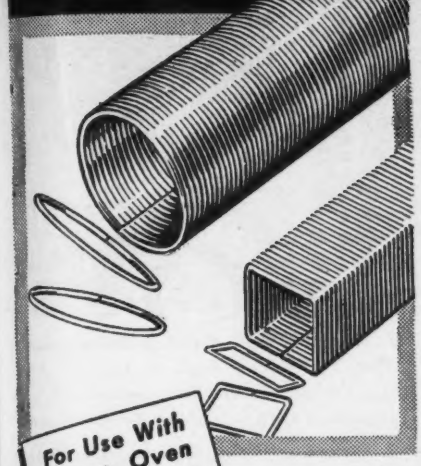

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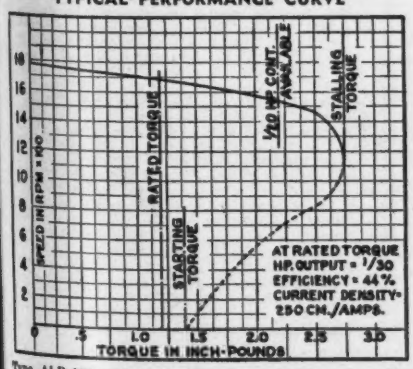
ELNICO TYPE ALP
TYPICAL PERFORMANCE CURVE



Type ALP-191; 110 volt 60 cyc. single-phase Capacitor start & run; Motor Capacitor Value 4.25 Mfd. Curve #235.

Elnico ALP Frame Motors are 3⅜" x 4-5/16" capacitor start and run, two and four pole AC motors, internal fan cooled. Continuous duty rating—as induction motor to 1/30 h.p. at 1700 r.p.m.; as synchronous motor to 1/60 h.p. at 1800 r.p.m. Substantially higher ratings are available at speeds of 3400 and 3600 r.p.m. respectively. Also, higher rating for intermittent duty.

ELECTRIC INDICATOR CO.
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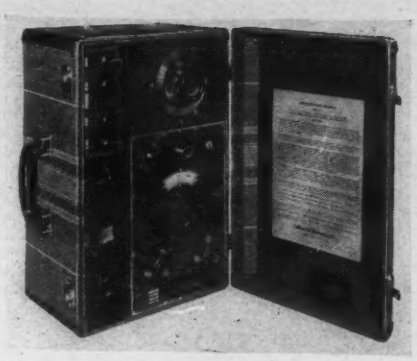
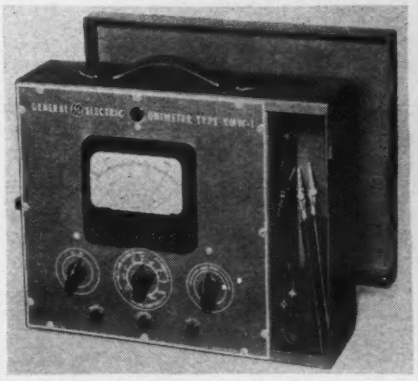


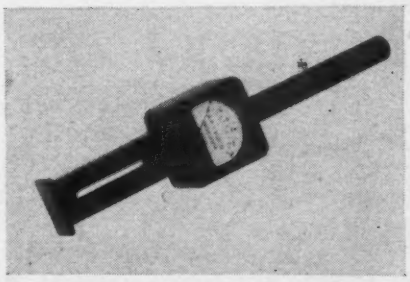
Conductivity Bridge

The electrical resistance method of measuring soil moisture is used in model RC-12C soil moisture conductivity bridge developed by Industrial Instruments, Inc., 17 Pollock Ave., Jersey City 5, N. J. The battery-operated, portable unit will measure soil moisture from field capacity to the air dry state, corresponding to a resistance range from 0.2 to 2,500,000 ohms. A CR tuning tube is used as balance indicator of the 1000 cps ac bridge.—Electronic Industries



New Unimeter

The Electronics Dept. of the General Electric Co., Syracuse, N. Y., has a new version of the well known Unimeter for measuring ac and dc voltage, dc current, resistance and decibels. Full scale ranges are 2.5 to 1000 dc volts at 20,000 ohms per range-volt; 2000 ohms to 20 megohms and 0.5 to 500 ma., while a separate capacity coupled jack provides ac ranges from 2.5 to 1000 volts and 3 to 52 decibels, based on a 6 mw, 500 ohms zero reference level.—Electronic Industries



R-F Probe

For exploring relative field strength in the neighborhood of high power rf equipment, the Radio Frequency Laboratories, Inc., Boonton, N. J., has introduced Model 200 R-F probe. An overall length of 11 in., including a probe element 5 in. by ¾ in. diameter, permits access to confined spaces. Two crystal rectifiers in the tip operate a Weston Model 506 meter, giving indications at frequencies up to 1500 mc. will withstand overloads equivalent to 10 times full scale deflection and is insulated to protect operators when probing high voltage power circuits.—Electronic Industries

Here's the Way to Spot Weld Instrument and Precision Equipment

- Vangtronic Self-Forging Stored Energy Spot Welder shown above is one of many used by The Foxboro Co., one of the largest instrument manufacturers.
- Welds are now being made which heretofore were practically impossible.
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. . . now available as pentodes, tetrodes, triodes and diodes operate at 10 milliamperes filament current, 10^{-14} amperes grid current, and have an extremely high grid resistance of 10^{16} ohms or greater.

Developed for the finest in instrumentation—solving the problem of making new and intricate circuits simple and feasible.

Victoreen vacuum sealed hi-megohm resistors have filled the void of quality resistances in a range from 100 to 10,000,000 megohms. Used wherever resistors of these values require unusual stability with relatively low temperature and voltage co-efficients.

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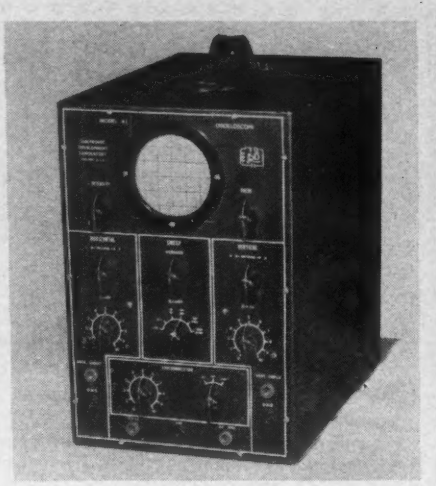
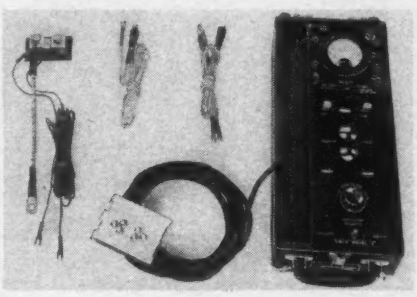
CLEVELAND 14, OHIO



General Purpose Oscilloscope

The Electronic Development Labs, 2655 W. 19th St., Chicago, is manufacturing a new portable cathode-ray oscilloscope havinga 3 in. viewing screen. Features include a linear sweep oscillator of the multivibrator type and extended range vertical and horizontal amplifiers. The sweep range is 10 to 60,000 c/s, amplifier response 10 to 150,000 c/s (-2 db.) and sensitivity 1 volt rms per inch of deflection. Tubes are of the "lock-in" type with the exception of one 5Y3 rectifier and the type 3AP1 cathode-ray tube.—Electronic Industries



Aircraft Analyzer

A portable aircraft analyzer for simultaneous checking of generator voltage, field current, regulator, generator relay, instruments and wiring of any plane is available from Airquipment Co., Dept. BK, 2820 Ontario St., Burbank, Cal. The analyzer may also be used as dc voltmeter with a 30, 300 and 1500 volt range or as an ammeter up to 300 amps.—Electronic Industries

Circuit Tester

Series 864, ac-dc laboratory circuit tester is in production at Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y. The instrument has a 9 in. rectangular meter and provides 41 ac-dc, volt-, milliamps-, ohm- and db meter ranges at a sensitivity of 5000 ohms per volt. Measurements are possible up to 6000 volts ac-dc, 20 megohms, 12 amps., and 70 db.—Electronic Industries

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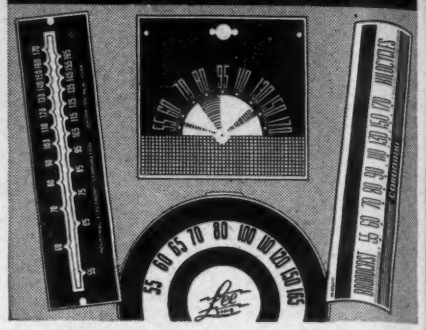
DIAL WINDOWS, NAME PLATES, GAUGES, CALCULATORS, SCALES, CHARTS, ETC.



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ALLOY "A"
Nickel - Chromium alloy, resists oxidation at elevated temperatures up to 2100° F. Also used for fixed non-magnetic resistors. Resists chemical corrosion by many media. Specific resistance 650 Ohms/C.M.F.

ALLOY "C"
Nominally 60% Nickel, 15% Chromium, balance iron. High resistance to oxidation and corrosion. Widely used for resistors for radio, electronics, industrial equipment and domestic appliances. Operating temperatures up to 1700° F. Specific resistance 675 Ohms/C.M.F.

ALLOY "45"
Copper - Nickel alloy with constant resistance over wide range of temperatures. Specific resistance 294 Ohms/C.M.F.; temperature coefficient 0.00002 Ohms per deg. F.; 32-212 deg. Used in winding of precision resistors, rheostats, and electrical measuring devices.

KANTHAL
Exclusive manufacturers and distributors of KANTHAL wire, ribbon and strip. An alloy containing Iron, Chromium, Aluminum and Cobalt . . . for operating temperatures up to 2462 F. Three grades, A-1, AS, DS; resistivity 872, 837, 812 Ohms C.M.F., respectively at 68° F.

AS FINE AS .0006" FOR ALLOYS, 'A,' 'C,' '45'

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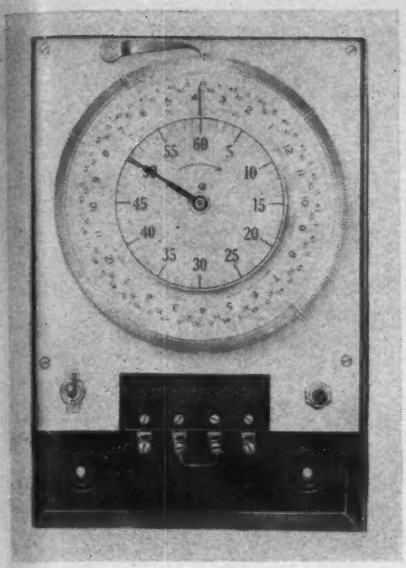
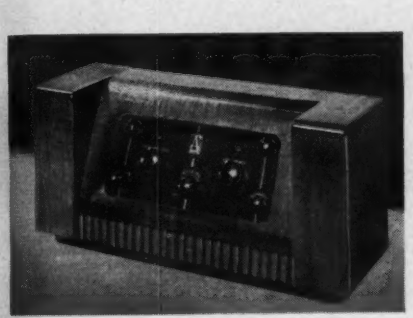


Program Time Switch

Zenith Electric Co., 152 W. Walton St., Chicago 10, Ill., is manufacturing a program time switch (type PR-24) which operates automatically to periods as close as five minutes throughout the twenty-four hours. The timer repeats daily requiring no resetting.—Electronic Industries



Audiometer

Audio Development Co., 28833—13th Ave., S. Minneapolis, Minn., is producing a new type of 100% dial-operated audiometer for accurate tests of hearing acuity. The instrument supplies a pure, continuous test tone at the six A.M. A. frequencies and has additional half-octave steps in the higher frequency range to 11,584 c/s. Hearing loss is evaluated in 5 db steps, maximum attenuation being 100 db from 512 to 4096 c/s, 80 db from 256 to 8192 c/s and 70 db from 128 to 11,584 c/s. No readjustment of the zero reference level is required when changing frequencies.—Electronic Industries

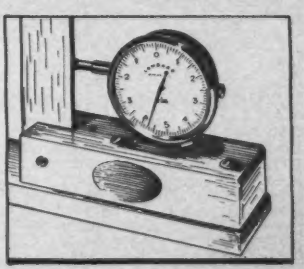
Communications Receiver

Allen D. Cardwell Mfg. Co., Plainville, Conn., has brought out a new communications receiver (Model CR-54) that covers all frequencies between 0.54 and 40.0 mc in six bands with provision for replacing the 540 to 1600 kc band with a 40 to 54 mc range. The receiver includes a crystal controlled secondary standard, has 18 miniature tubes and a turret type rf amplifier. It is self-contained except for the speaker, power output being 8-10 watts. Other features include a series diode noise limiter, crystal filter and IF amplifier, tone controls, temperature compensated oscillator, phono input, Panoramic adaptor, provision for control of external relay, tuning meter, mechanical linkage provisions through extension of shafts out back, threshold squelch circuit, wide bandspread, control locks, 8-in. PM speaker.—Electronic Industries

Sweep Frequency Record

A new method of evaluating the frequency response of phonograph playback equipment has been developed by the Clarkstan Corp., 11927 W. Pico Blvd., Los Angeles 34, Calif. Special vinylite pressings of a frequency modulated signal have been prepared for use with a cathode-ray oscilloscope, permitting continuous observation of playback frequency response during adjustment and testing of phonograph reproducers, amplifiers, audio equalizers, etc. The range of 100 to 10,000 c/s is scanned continuously at the rate of 20 sweeps per second, with a 200 microsecond pulse at the start of each sweep for synchronizing the oscilloscope time base oscillator. The recording is at constant amplitude below 500 c/s and constant velocity above this frequency, conforming to the N.A.B. specifications within 1 db. Frequency varies logarithmically with respect to time and is identified by marker pulses at intervals of 2,000 c/s. These pressings are available in either 10 in., 78 rpm, or 16 in., 33⅓ rpm types.—Electronic Industries

New Micro Square Instantly Checks Right Angles to One 10,000th Inch!



Standard Indicator Dial

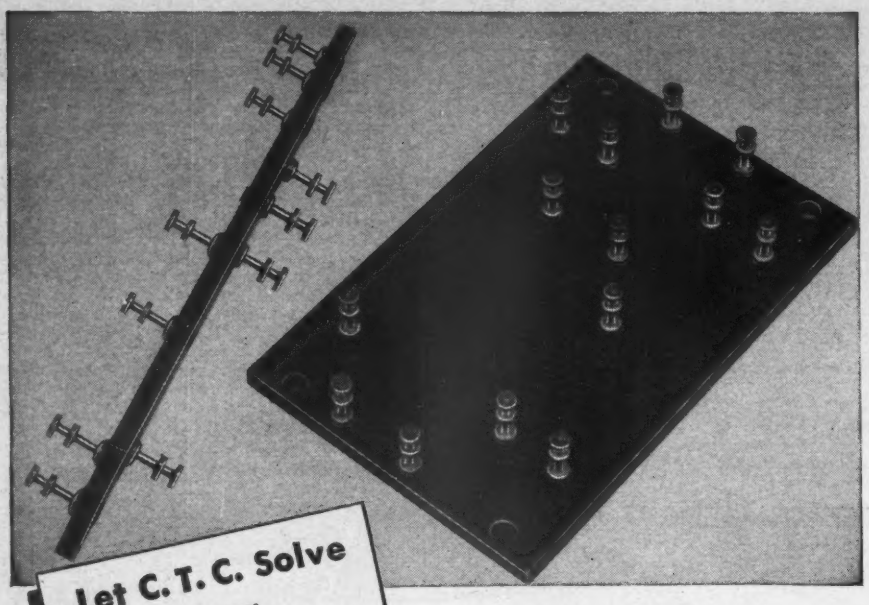
Ideal for precision testing, the Acro Micro-Sine Square quickly and accurately checks right angle work to 1/10,000th inch within a given distance. Its standard indicator dial instantly registers error, location of error, and amount of correction required. Designed for tool and die shops, machine shops and testing laboratories, it also provides a standard for checking master squares, tri-squares and tools.

The Acro Micro-Sine Square is very simple to operate, saves hours of time. Made of hardened tool steel, in ground and lapped precision construction. Available in two types: (1) Standard precision gauge in tenths, (2) Lever indicator in thousandths. Both complete with master checking blocks and carrying cases.

On precision jobs, requiring a static position and mental alertness, workers undergo nervous tension which often results in fatigue. Tests have shown that the act of chewing helps relieve tension—helps workers stay alert, thus increasing their efficiency to do more accurate work. For this reason, many plant owners urge workers to chew Wrigley's Spearmint Gum on this type of job.

You can get complete information from Acro Tool and Die Works 4554 Broadway, Chicago 40, Illinois

AA-88



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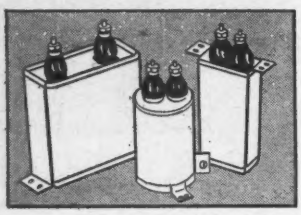

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3C7	6 Mfd	600	8.10	1.15	1.05	.90
72C637	10 Mfd	600	10.80	1.35	1.20	1.00
A9C173	15 Mfd	600	17.65	2.25	2.00	1.80
35C311	2 Mfd	1000	6.00	.90	.80	.70
A9C174	10 Mfd	1000	12.00	2.25	2.15	1.95
D1C276A	4 Mfd	1500	10.00	2.25	2.15	1.95
A9C171	10 Mfd	1500	18.00	2.95	2.75	2.50
76C787	4 Mfd	2000	10.80	2.95	2.75	2.50
76C791	10 Mfd	2000	22.00	4.60	4.35	4.00
A4C124	Dual 1 Mfd	3000	18.80	2.95	2.75	2.50
63C574	1 Mfd	3600	26.50	2.45	2.25	1.90
92C782	.1 Mfd	7000	28.00	2.45	2.25	1.90

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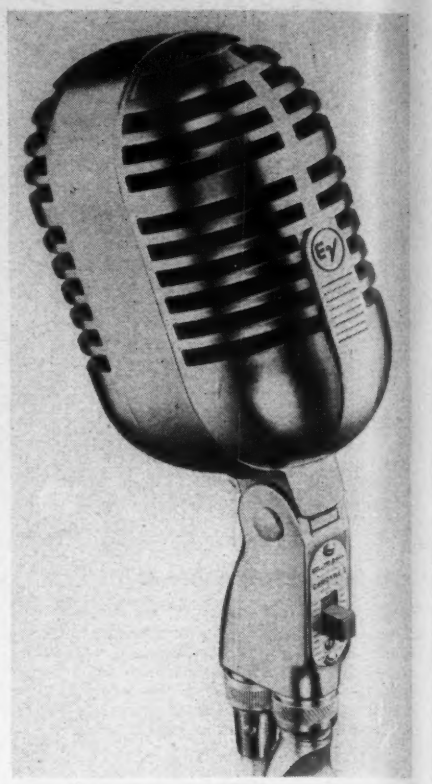

Dynamic Microphone

The Cardyne, a single-head cardioid dynamic microphone is being offered by Electro-Voice, South Bend, Ind. The output level of the unit is 53 db below 1 volt/dyne/cm². Units can be supplied with impedances of 50, 250, 500 and 25,000 ohms. Two models are available, model 731 with a frequency response substantially flat from 30 to 12,000 cps and model 726 having a response from 40 to 10,000 cps.—Electronic Industries

FM Channel Numerology

Basic mathematical advantages of the new FM channel numbering system.

Since the Federal Communications Commission has instituted a channel numbering system for the new frequency modulation allocations in the 88 to 108 mc band, the public will soon be confronted with FM receiver dials bearing such numbers as 213, 289, 254, etc. The new system (illustrated in the accompanying chart) constitutes a major advance in the art of high frequency measurement and will no doubt place electronic engineering on a new (and more exclusive) plane of scientific endeavor.

The new units of frequency bear a simple algebraic relationship to the old "megacycle" units, as will be shown. If we let cu = channel units, and f = the corresponding frequencies, in megacycles per second, we can make the general statement:

$$f_{(cu=0)} = f - cu\Delta f \qquad (1)$$

By inspection of Table 1, $\Delta f = 0.2$ (mc). Selecting any corresponding

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values of cu and f from Table 1, such as cu = 230 and f = 93.9, and substituting these, together with the numerical value of Δf, we have:

$$f_{(cu=0)} = 93.9 - (230 \times 0.2) = 47.9 \quad (2)$$

The curve of dcu/df obviously contains a constant, k, equal to 47.9, therefore:

$$f = cu\Delta f + k \quad (3)$$

$$= 0.2cu + 47.9 \quad (4)$$

Expressing (3) in terms of cu, we have:

$$cu = \frac{f - k}{\Delta f} \quad (5)$$

which we know to be

$$c = \frac{f - 47.9}{0.2} = 5(f - 47.9) \quad (6)$$

Of course, values of cu below cu = 201 are imaginary, since FCC assignments start with channel number 201. Therefore Table 1 deals only with real functions of cu. Future assignments below number 201 will, in all probability, follow a different mathematical law, since the science of frequency allocation must be flexible enough to keep step with the rapid advance of electronic engineering.

Some ultra-conservatives may not appreciate the advantages of substituting simple round numbers for the now obsolete megacycle units of frequency. However, the writer is convinced that the FCC practice of expressing radio frequencies in terms of "cu" (channel units, not copper) should be extended to FM engineering in general, thus eliminating the more cumbersome cycles, kilocycles, megacycles, etc. When referring to channel units per second, the abbreviation "cup/s" should be used, while for uhf work, the abbreviated form should be cuhfp/s.

Aside from the many engineering advantages of the improved FM numerology, the following business aspects of the new system should be noted:

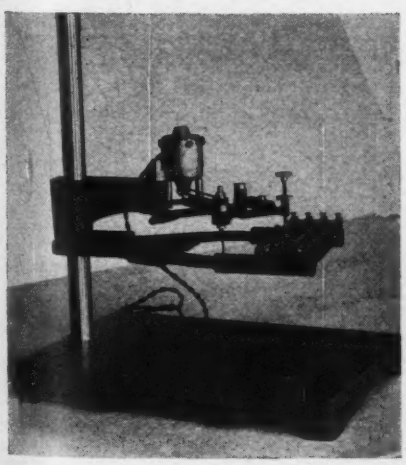
(1) The term "megacycles" will no longer frighten prospective buyers of FM sets.

(2) FM engineers will have a distinctive unit of frequency, not easily confused with units used by other branches of the physical sciences.

(3) Test equipment manufacturers can add an FM dial scale to their signal generators that will bear no confusing relationship to any other dial-scale.

(4) Slide rule manufacturers will have a potential market for gadgets that will solve problems in terms of "cu".

—MICO—
ENGRAVER



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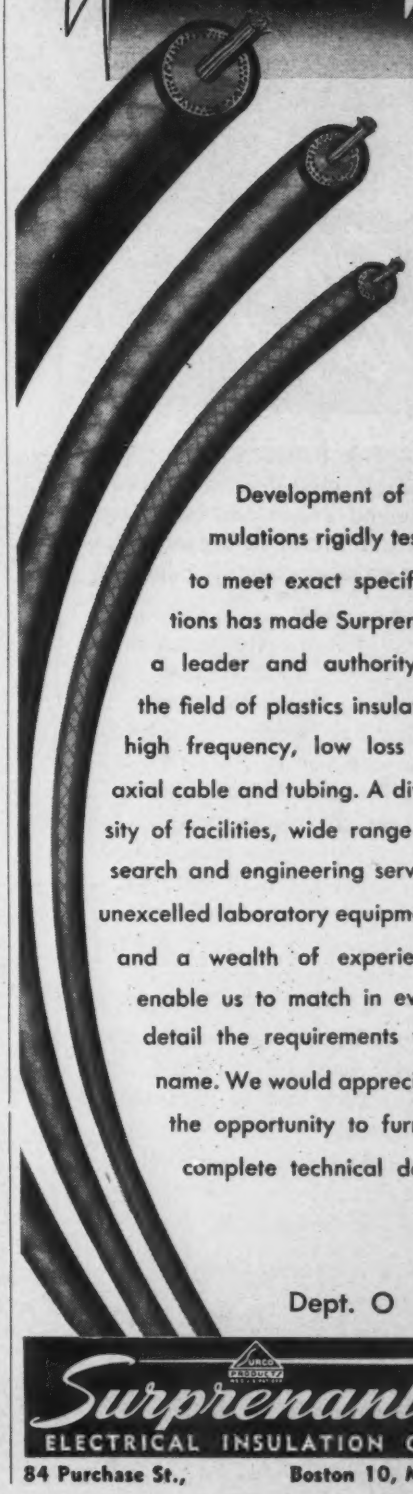

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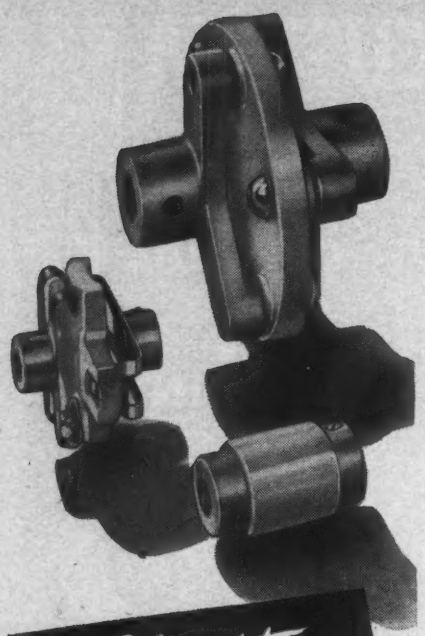

Shaft Couplings

A link between control and variable circuit element, shaft coupling design can be an important factor in proper functioning of electronic equipment.

Illustrated are but three of many Johnson insulated shaft couplings; among them units providing a high degree of flexibility but freedom from backlash common to others resembling them; rigid types where accurate shaft alignment is required and torque may be high; bar types for high voltages or very high frequencies. All are characterized by best steatite insulation properly proportioned for electrical and mechanical strength, by accurate metal parts finished to stand salt spray test, and by those little evidences of Johnson engineering and manufacturing skill that are most appreciated only after use and comparison.

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(5) Newsstands can supply monthly horoscopes showing where new broadcasting allocations stand with respect to the zodiac.—P.H.

TABLE I.
CHART FOR CONVERTING CHANNEL NUMBERS TO MEGACYCLES

Channel No. (CU)	Frequency (MC)	Channel No. (CU)	Frequency (MC)
201	88.1	251	98.1
202	88.3	252	98.3
203	88.5	253	98.5
204	88.7	254	98.7
205	88.9	255	98.9
206	89.1	256	99.1
207	89.3	257	99.3
208	89.5	258	99.5
209	89.7	259	99.7
210	89.9	260	99.9
211	90.1	261	100.1
212	90.3	262	100.3
213	90.5	263	100.5
214	90.7	264	100.7
215	90.9	265	100.9
216	91.1	266	101.1
217	91.3	267	101.3
218	91.5	268	101.5
219	91.7	269	101.7
220	91.9	270	101.9
221	92.1	271	102.1
222	92.3	272	102.3
223	92.5	273	102.5
224	92.7	274	102.7
225	92.9	275	102.9
226	93.1	276	103.1
227	93.3	277	103.3
228	93.5	278	103.5
229	93.7	279	103.7
230	93.9	280	103.9
231	94.1	281	104.1
232	94.3	282	104.3
233	94.5	283	104.5
234	94.7	284	104.7
235	94.9	285	104.9
236	95.1	286	105.1
237	95.3	287	105.3
238	95.5	288	105.5
239	95.7	289	105.7
240	95.9	290	105.9
241	96.1	291	106.1
242	96.3	292	106.3
243	96.5	293	106.5
244	96.7	294	106.7
245	96.9	295	106.9
246	97.1	296	107.1
247	97.3	297	107.3
248	97.5	298	107.5
249	97.7	299	107.7
250	97.9	300	107.9

Instrumentation Meet Schedules 30 Papers

The preliminary technical program for the Instrumentation for Tomorrow conference and exhibition slated for Pittsburgh's William Penn Hotel during the five days starting September 16, covers nine general subjects and includes more than 30 papers. The list of exhibitors, numbering over 100, was published in Electronic Industries for August. The tentative conference program follows:

MEASUREMENT AND CONTROL

"Design of Instrument Air Supply Systems for the Process Industry"—W. C. Ludi, Standard Oil Development Co.

"Control of Reactors"—E. E. Rowland, Office

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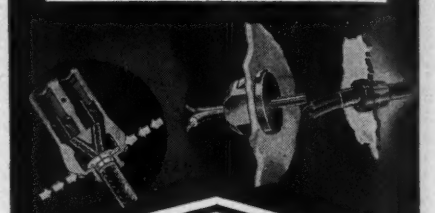

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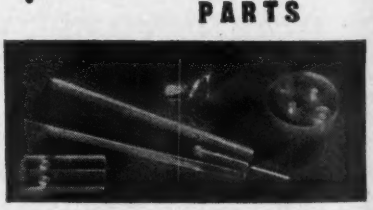

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of Rubber Reserve, University of Akron.

"Organization of an Instrument Department" —Paul Exline, Gulf Research & Development Corp.

"Design of Thermocouple and Thermometer Wells"—George R. Feeley, Trinity Equipment and Supply Co.

"Requirements for Satisfactory Installation and Initial Operation of Measurement and Control Instruments on Large Process Units"—Harry Moore, Standard Oil Development Co.

INSPECTION AND TESTING

"Surface Finish Standards" — W. Mikelson, General Electric Co.

"Surface Measurement Instrumentation" — James A. Broadston, North American Aviation, Inc.

"Recent Trends in Electric Gaging Methods" —Howard Roberts, University of Illinois.

"Supersonic Inspection"—J. W. Dice, Sperry Products, Inc.

"Training in Inspection and Gaging"—Professor Roger L. Geer, Cornell University.

INSTRUMENT RESEARCH

"An Institute for Instrument Research"—Ralph H. Miller, New York University.

"Instrument Developments in Britain"—H. B. Cronshaw, London, England.

SCIENTIFIC INSTRUMENTATION

"Manometers for Extremety Low Pressures"—Saul Dushman, General Electric Co.

"Sound and Vibration Measurement"—H. A. Leedy, Armour Research Foundation.

"Spectroscopy and Petroleum Industry"—S. C. Fulton of Esso Laboratories.

COMPONENTS AND MATERIALS

"Instrument Bearings"—J. H. Goss, General Electric Co.

"Synthetic Lubricants for Instruments"—G. E. Barker, Atlas Powder and G. E. Alter, Mellon Institute of Industrial Research.

"Instrument Springs"—John Rockefeller, Jr., All Weather Springs Co.

"How Special Metals Solve Instrument Problems"—Robert Carson, Instrument Specialties Co., Inc.

"Relays"—C. A. Packard, Struthers-Dunn, Inc.

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"Functional Analysis of Measurement Apparatus"—H. G. Dickinson, General Eelctric Co.

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Electronics Conference Has Exhibit, 60 Papers

National Electronics Conference, opening early next month (October 3, 4, 5) at the Edgewater Beach Hotel, Chicago, is to include what has been described as an extensive exhibit of radio and electronic equipment. In all, some 60 papers

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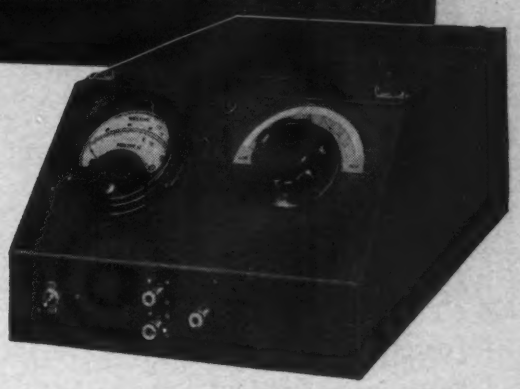

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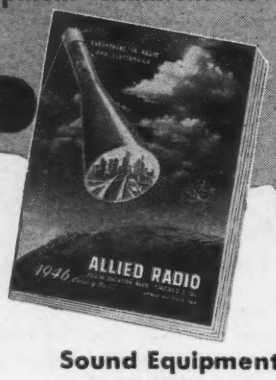

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are to be presented by a long list of authors well known in the industry.

The Conference is sponsored by the Illinois Institute of Technology, Northwestern University and the University of Illinois, together with the Chicago sections of IRE and AIEE. Dr. J. E. Hobson, Armour Research Foundation, is chairman of the board of directors of the gathering; W. O. Swinyard, Hazeltine Electronics Corp., is president.

In addition to the speakers whose papers are listed below, addresses on "Electronics and the Future" will be made by Dr. E. U. Condon, director of the National Bureau of Standards; on a subject to be announced, by Dr. F. L. Hovde, president of Purdue University; on "Physics of Today Becomes the Engineering of Tomorrow," by G. G. Suits, vice-president of General Electric Co.; and on "Microwaves and Radar," by J. O. Perrine, vice-president of Bell Telephone Laboratories. Remainder of the program follows:

TELEVISION

Color Television—Latest State of the Art—Dr. Peter Goldmark, Columbia Broadcasting System

Westinghouse Color Television Studio Equipment—D. L. Balthis, Westinghouse Electric Corp.

Television Transmitter for Black and White and Color Television—N. Young, Federal Telecommunication Lab.

Stratovision System of Communication—C. E. Nobles, Westinghouse Elec. Corp., and W. K. Ebel, Glenn L. Martin Co.

The Electrostatic Image Dissector—Dr. H. Salinger, Farnsworth Television Radio Corp.

The Use of Powdered Iron in Television Deflecting Circuits—A. W. Friend, Radio Corp. of America

ANTENNAS AND WAVE PROPAGATION

Problems in Wide-Band Antenna Design—A. G. Kandoian, Federal Telecommunication Lab.

Slot Radiators—Dr. A. Alford, Consulting Engineer

Propagation of U.H.F. Signals—W. B. Lodge, Columbia Broadcasting System

Radio Propagation at Frequencies above 30 MC—K. Bullington, Bell Telephone Laboratories

Interference Between VHF Radio Communication Circuits—W. R. Young, Jr., Bell Telephone Laboratories

Aircraft Antenna Pattern Measuring System—Otto Schmitt, Airborne Instruments Lab.

Improvements in 75 MC Aircraft Marker Systems—B. Montgomery, United Airlines

MICROWAVE GENERATORS

Continuous-Wave U.H.F. Power at the 50 KW Level—Prof. W. G. Dow, University of Michigan

Microwave Frequency Stability—Dr. A. E. Harrison, Sperry Gyroscope Co.

An All-Metal Tunable Squirrel-Cage Magnetron—Dr. F. H. Crawford, Williams College

Design of Wide-Range Coaxial-Cavity Oscillators Using Reflex Klystron Tubes—J. W. Kearney, Airborne Instruments Lab.

AIR-NAVIGATION SYSTEMS

Automatic Radio Flight Control—F. L. Moseley, Collins Radio Co.

Aerial Navigation—P. Adams and R. I. Colin, Federal Telecommunication Lab.

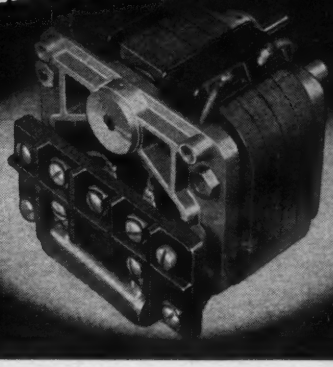
Teleran-Air Navigation and Traffic Control by Means of Television and Radar—D. H. Ewing and R. W. K. Smith, Radio Corp. of America

RADIO RELAY SYSTEMS

Development of a Microwave Relay Communication System—G. G. Geralch, Radio Corp. of America

Multiplex Broadcasting—D. D. Grieg and A. D. Kandoian, Federal Telecommunication Lab.

BARCOL



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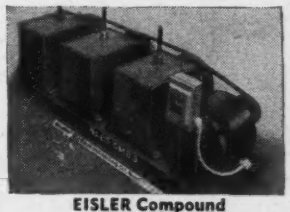

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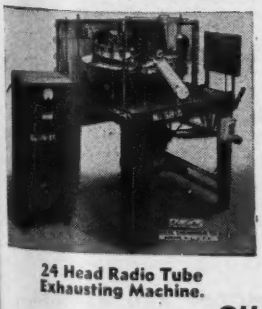

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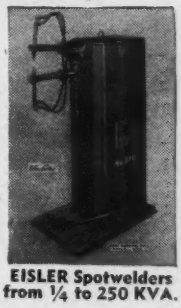

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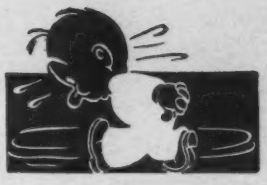
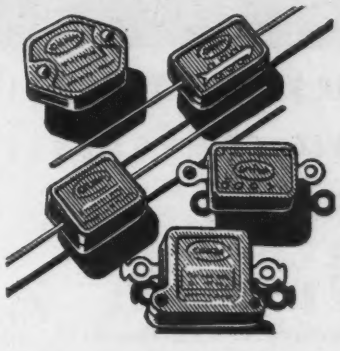


CAPACITORS



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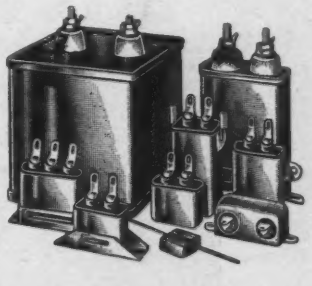

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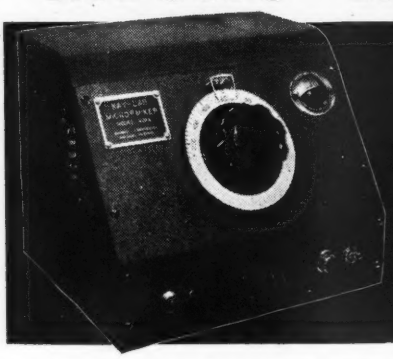

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Manufacturers Representatives are invited to reply.

The Cyclophon—J. J. Glauber, Federal Telecommunication Lab.
The Theory and Design of Several Types of Wave Selectors—N. I. Korman, Radio Corp. of America

FREQUENCY MODULATION

A Permeability-Tuned 100 MC Amplifier—Z. Benin, Zenith Radio
VHF Tuner Design—G. Wallin and C. W. Dymond, Galvin Mfg. Co.
Front-End Design of FM Receivers—I. J. Kaar, General Electric Co.
FM Limiter of the Locked-in Oscillator Variety—D. Smith, Philco Radio & Television

MOBILE RADIO COMMUNICATION

A panel on selective-calling systems in mobile radio communication will be included.

INFRARED COMMUNICATION SYSTEMS

Modulation of Infrared Systems for Signaling Purposes—Dr. W. S. Huxford, Northwestern University
Photo Detectors for Ultraviolet, Visible, and Infrared Light—Dr. R. J. Cashman, Northwestern University

RECORDING AND FACSIMILE

Review of Facsimile Developments—H. F. Burkhard, Camp Coles Signal Lab.
The Reduction of Background Noise in the Reproduction of Music from Records—H. H. Scott, Technology Instrument Co.
Recent Developments in Magnetic Recording—Dr. R. B. Vaile, Jr., Armour Research Foundation

THEORETICAL DEVELOPMENTS

Bunching Conditions for Electron Beams with Space Charge—Dr. L. Brillouin, Cruft Lab., Harvard University
Generalized Boundary Conditions in Electro Magnetic Problems—Dr. S. A. Schelkunoff, Bell Telephone Laboratories
Conformal Transformations in Orthogonal Reference Systems—Dr. C. E. Roys, Illinois Inst. of Technology

INDUSTRIAL APPLICATIONS

Large Electronic DC Motor Drives—M. M. Morack, General Electric Co.
Electronic Speed Control of AC Motors—W. H. Elliot, Cutler-Hammer Co.
The Electronic Contour Follower Control—J. Morgan, General Electric Co.
Production Test Facilities for High Power Tubes—W. L. Lyndon, Radio Corp. of America

ELECTRONIC INSTRUMENTATION

A Method for Changing the Frequency of a Complex Wave—E. L. Kent, C. G. Conn, Ltd.
Cathode Ray Oscilloscope as a Research Tool—W. L. Gaines, Bell Telephone Laboratories
The Pressuregraph—A. Crossley, Alfred Crossley Associates
The Notch Wattmeter—D. F. Bowman, Hazeltine Electronics Corp.
The Mechanical Transients Analyzer—G. D. McCann, Westinghouse Electric Corp.
Detectors for Buried Metallic Bodies—L. F. Curtis, Hazeltine Electronics Corp.
High Performance Demodulators for Servomechanisms—K. E. Schreiner, M.I.T. Servomechanism Lab.

HIGH FREQUENCY HEATING

Ignitron Converters for Induction Heating—R. J. Ballard and J. L. Boyer, Westinghouse Electric Corp.
Microwaves and Their Use in High Frequency Heating—T. P. Kinn, Westinghouse Electric Corp.
Dielectric Pre-Heating in the Plastics Industry—D. E. Watts, G. F. Leland and T. N. Wilcox, General Electric Co.
The Problem of Constant Frequency in Industrial High Frequency Generators—Dr. E. Mittelmann, Illinois Tool Works

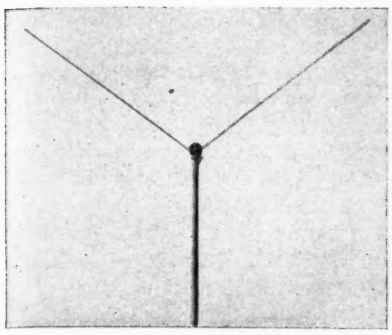
NUCLEAR PHYSICS

The Betatron Accelerator Applied to Nuclear Physics—Dr. E. E. Charlton and W. F. Westendarp, General Electric Co.
Some Fundamental Problems of Nuclear Power Plant Engineering—E. T. Neubauer, Allis-Chalmers Co.
An Accelerator Column for Two to Six Million Volts—R. R. Machlett, Machlett Laboratories.

SPECTROSCOPY AND MEDICAL APPLICATIONS

The Use of Radioactive Materials in Clinical Diagnosis and Medical Therapy—J. T. Wilson, Allis-Chalmers Co.
The Mass Spectrometer as an Industrial Tool—Dr. A. O. Nier, University of Minnesota
Cathode Ray Spectograph—R. Feldt and C. Berkley, DuMont Laboratories

PREMAX



ANTENNAS for FM and Television

"FM and Television Bulletin No. 4612" gives complete details of two new type Premax Antennas, one of which will give satisfactory performance on BOTH FM and Television. Send for it today.

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Tocco Reorganizes Heating Division

Ohio Crankshaft Co., Cleveland, has reorganized its Tocco heating division and created a commercial engineering department which will plan all phases of basic engineering on induction heating projects. The new department will be headed by Harry T. Keller, for the past 25 years in charge of engineering standards for Buick Motor Co. Other changes involve promotion of Dr. Harry B. Osborn, Jr., formerly research and development engineer, to be sales manager of the division; John T. Vaughn to be research and development engineer; A. H. Pittaway to be laboratory superintendent; and John Gibbons to be office supervisor. Tinkham Veale continues as head of production engineering and A. O. Wood as chief engineer.

Lynch Re-enters Trade

Arthur H. Lynch, long time (and still) New York manager for the National Co., Malden, Mass., has joined forces with J. Allen Biggs to form Lybig Sales Corp., and will do business as the selling representatives of several manufacturers, from headquarters at 136 Liberty Street, New York. Lynch is president of the organization and Biggs, who recently left International division of RCA, is vice-president. Current accounts include representation of Radio Music Corp., East Portchester, N. Y. (phono pick-ups); Islip Radio Mfg. Co., Islip, Long Island (marine radio equipment); Taybern Equipment Co., New York (electronic megaphone).

One in Five FM Channels Reserved

Following a public hearing held July 12, 1946, the Federal Communications Commission has adopted an order withholding for the period ending June 30, 1947, the assignment of one out of every five Class B channels which have been tentatively allocated for various areas throughout the United States.

Under the reservation plan no reservation of channels will be made if a maximum of four channels is indicated for a particular area in the December 19, 1945, order. However, if at least five but no more than nine channels are indicated for an area, one channel will be withheld for the period ending June 30, 1947. Two channels will be withheld if 10-14 channels are listed;

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- Contact ratings up to 15 amperes on low voltage.
- High quality construction — mechanically rugged.
- Very low cost.

SIGMA sales and engineering departments are ready to give your relay problems prompt analysis and action.

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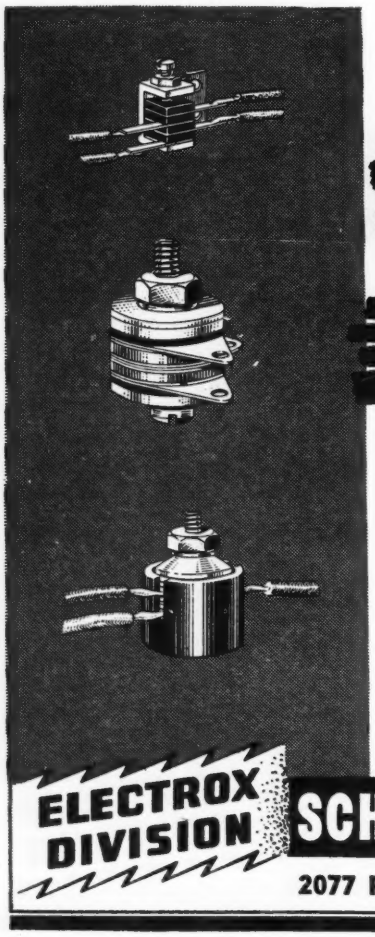

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three, if 15-19 are listed; and four, if 20 are listed.

Persons desiring to be considered for the reserved channel or channels in a given area may submit their applications prior to June 30, 1947. Such applications will be received, will be assigned a file number, and will be placed in a pending file for consideration after July 1, 1947. However, they will not be given the status of pending applications for the purpose of giving the applicant any legal or equitable right as an applicant during the interim period. Applicants for reserved channels, who file at any time during the interim period, will be given equal consideration regardless of the dates upon which their respective applications were filed.

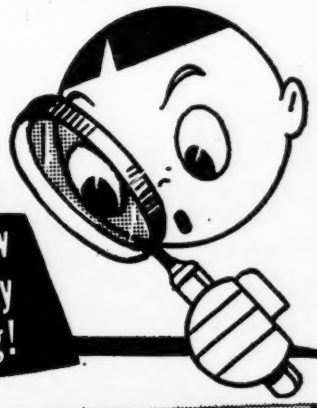
Thomas Lord Heads Lord Mfg. Co.

Thomas Lord, vice-president of Lord Mfg. Co., Erie, Pa., has been elected president of the company to succeed his father, H. C. Lord, who becomes chairman of the board, announces B. M. Hartman, secretary-treasurer. The company is the outcome of inventions and developments of H. C. Lord, starting in 1919. Primary purposes of these inventions have been to protect equipment and sensitive apparatus from shock and to prevent the transfer of noise and vibration to adjoining structures and areas. Early researches developed joints between metal parts, the joint accommodating the movement caused by the distortion of rubber, thus avoiding lubricants. A feature of the Lord inventions is rubber bonded to metal. The company now manufactures a large variety of both standardized and specially designed products with a wide range of applications in the field of vibration control.

Water Repellent Materials

Dri-Film water-repellent materials comprise a series of General Electric products made in the course of its developments in the silicone field and were first used during the war for the treatment of ceramic insulators for radio and other communication equipment used by the armed forces. Insulators, of course, lose effectiveness when exposed to high humidity. One of the most recent applications was for hearing-aids in which Dri-Film is used to treat vacuum tubes.

LOOKING FOR TIME AND LABOR-SAVING IDEAS?



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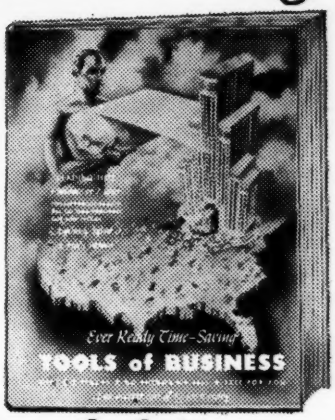

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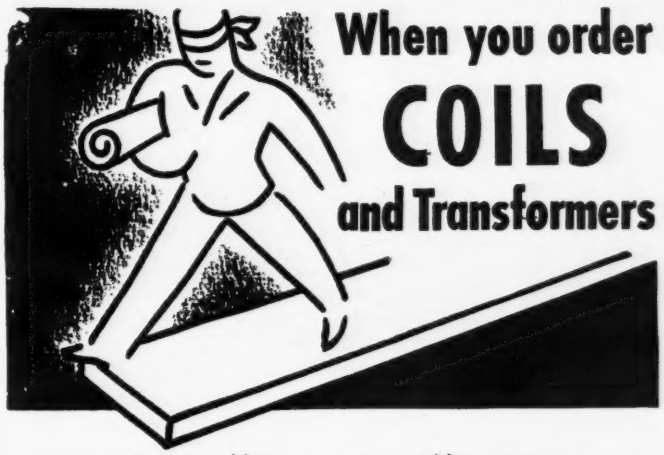

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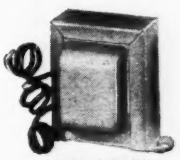

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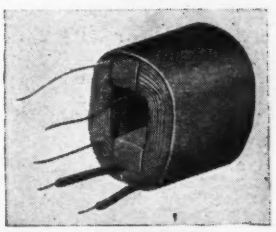

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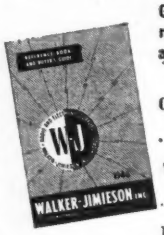

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Engineers Inspect Foreign Equipment

A large number of officials and engineers and research experts of leading radio-electronic manufacturing companies, together with high government officials and Army and Navy top-ranking officers, attended the exhibit of more than 300 items of German and Japanese electronic and communications equipment in the main lobby of the Department of Commerce Building in Washington during August. The exhibit was aranged by the Technical Industrial Intelligence Branch of the Commerce Department's Office of Technical Services in cooperation with the U. S. Army Signal Corps and the Naval Research Laboratories under direction of Edwin Y. Webb, Jr., Chief of the TIIB Electronics and Communications Unit.

Former NEID Men Open as Consultants

Electronic Associates, Inc., has been organized and will establish headquarters in Princeton, N. J., to function as engineering consultants on radio and industrial electronic equipments. President is Lloyd F. Christianson; Arthur L. Adamson is vice-president, secretary and treasurer; Joseph R. Troxel is vice-president and commercial manager; Charles M. Shedlbauer is chief engineer. All were formerly members of the Army's New Equipment Introductory Detachment (NEID). A temporary laboratory has been located at 61 Brighton Avenue, Long Branch, N. J.

Bus Owners Permitted Own Radio System

Public service bus companies are to be permitted by FCC (1) to use a cooperatively-owned communications organization, (2) to use an existing general communications common carrier—such as the telephone companies, (3) to apply for, and use if granted permission, individual communications facilities. These things were decided by FCC on July 11, following hearings held a month previously. Hearings were held to determine whether the country's bus companies should be required to use existing common carrier facilities, and whether they should be required to share frequencies with other users, such as trucks. FCC said no to both. It is expected now that National Bus Communications, Inc., which brought about the decision, will go ahead with plans for the establishment and equipment of a cooperatively-owned system to serve such bus owners as elect to use the service. Such a system involves the use of a microwave repeater arrangement. It is pointed out by FCC that in virtually giving the go ahead to Nabco, that organization's specific plan has not been definitely approved, that bus operators will not be required to use such services, that FCC is not bound to limit licensing to any single industry-formed entity. Frequency allocations have not been made, will be within the band allocated for general mobile radio service, must await further hearings.

To Make Rectifiers

Charles R. Ogle, formerly with the rectifier department of the Benwood-Linze Co., and more recently with the P. R. Mallory Co., has formed his own company and will do business as Electronic Rectifiers, Inc., from headquarters at 737 North East Street, Indianapolis, Ind. Associated with him is Paul B. Freeman, formerly in the rectifier engineering department of Mallory. The new company will manufacture a new type of magnesium copper sulphide rectifier, later to be supplemented by other products.

Vokar in East

An Eastern office has been opened by Vokar Corp., Dexter, Mich., Precision Parts Co., Ann Arbor, Mich., and its Chicago subsidiary, Carter Radio Division. It will be in charge of Henry D. Sarkis. The new office, located at 43 Water Street, New York, will serve the Eastern Atlantic states.

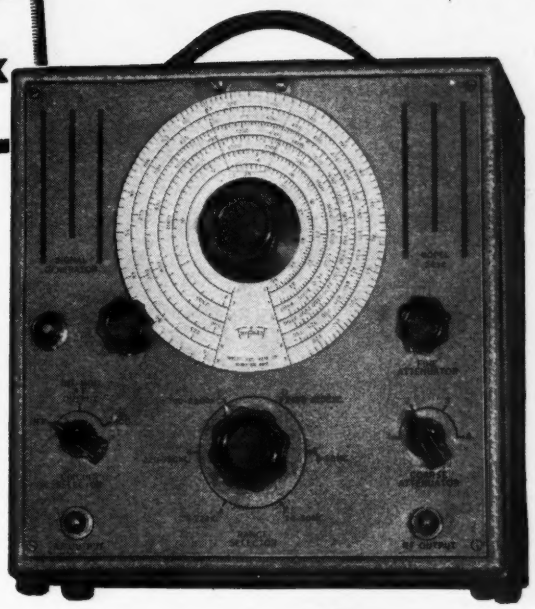
National Union Adds Home Sets

National Union Radio Corp., Newark, N. J., has added receiving sets to its line of electronic equipment and parts. Model G-619, 6-tube ac-dc receiver is the first of a series of 5 diversified models soon to be announced.

DX Radio Moves

General offices and production facilities of DX Radio Products have been moved to 2310 Armitage Avenue, Chicago. The business is to be housed in a new building which represents an increase of 20,000 sq. ft.

For the Man Who Takes Pride in His Work



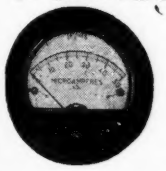
MODEL 2432 SIGNAL GENERATOR

Another member of the Triplett Square Line of matched units this signal generator embodies features normally found only in "custom priced" laboratory models.

FREQUENCY COVERAGE—Continuous and overlapping 75 KC to 50 MC. Six bands. All fundamentals. TURRET TYPE COIL ASSEMBLY—Six-position turret type coil switching with complete shielding. Coil assembly rotates inside a copper-plated steel shield. ATTENUATION—Individually shielded and adjustable, by fine and coarse controls, to zero for all practical purposes. STABILITY—Greatly increased by use of air trimmer capacitors, electron coupled oscillator circuit and permeability adjusted coils. INTERNAL MODULATION—Approximately 30% at 400 cycles. POWER SUPPLY—115 volts, 50-60 cycles A.C. Voltage regulated for increased oscillator stability.

CASE—Heavy metal with tan and brown hammered enamel finish.

There are many other features in this beautiful model of equal interest to the man who takes pride in his work.



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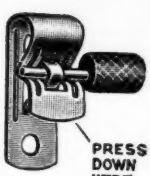

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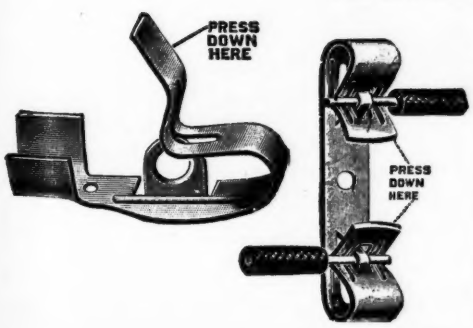
Positive contact; cannot jar loose. Brass or bronze — nonrusting.



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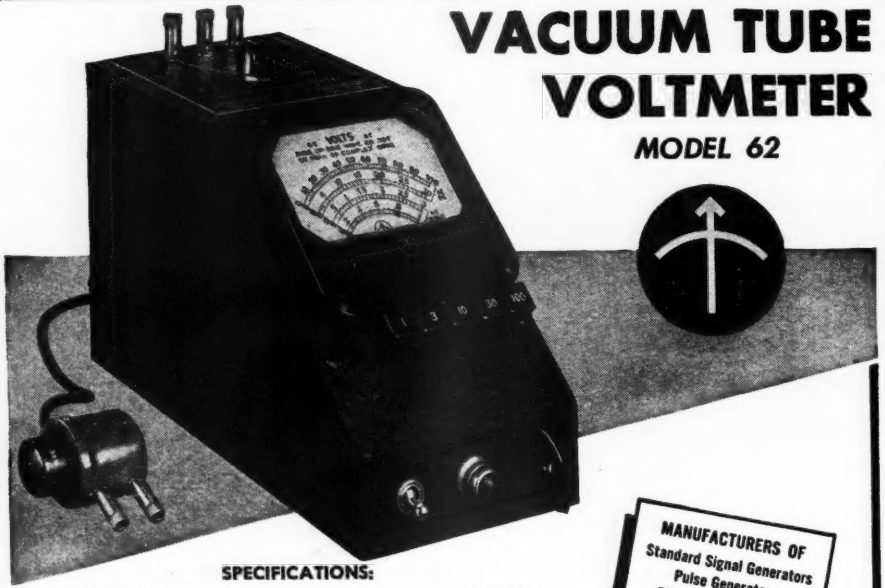
MODEL 62



SPECIFICATIONS:

RANGE: Push button selection of five ranges—1, 3, 10, 30 and 100 volts a.c. or d.c.

ACCURACY: 2% of full scale. Useable from 50 cycles to 150 megacycles.

INDICATION: Linear for d.c. and calibrated to indicate r.m.s. values of a sine-wave or 71% of the peak value of a complex wave on a.c.

POWER SUPPLY: 115 volts, 40-60 cycles—no batteries.

DIMENSIONS: 4¾" wide, 6" high, and 8½" deep.

WEIGHT: Approximately six pounds. *Immediate Delivery*

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WIL-FM is First in St. Louis Area

Edward F. Classen, Jr., sales engineer for R.E.L. Equipment Sales, Inc., 612 No. Michigan Avenue, Chicago, calls attention to the fact that radio station WIL-FM is the first FM broadcaster in St. Louis, having put out its initial program on June 20 and since carried a 7-hour daily schedule. The station is owned and operated by Missouri Broadcasting Corp. Meantime, Federal Telephone and Radio Corp. has sold to and is installing a 50kw FM station for KWK and a 10kw station for WEW, both to be on the air later in the summer. Advertisements in our August issue, necessarily prepared many weeks before publication, had stated that the latter two stations are "the first two FM stations in the St. Louis Area", whereas actually WIL-FM was the first St. Louis station to broadcast.

Decide German Patent Situation

During July, a twelve-nation conference was held in London to determine the treatment to be given German owned patents granted in the respective countries. An accord was reached which will become effective upon acceptance by three countries besides France, the Netherlands, the United Kingdom, and the United States, which have already signed.

A principal provision of the accord is that all patents issued by an adhering Government which were wholly German owned, shall be either dedicated to the public, or placed in the public domain, or continuously offered for licensing free of royalty to the nationals of all adhering Governments. All rights are granted on a reciprocal basis in all adhering countries.

It is to be expected that in the United States, the third alternative will be followed of offering former German owned patents for licensing free of royalty. This will involve no change in the licensing procedure which has been followed during the war as to U. S. citizens by the U. S. Alien Property Custodian, and there will be no change in the status of existing licenses already granted. Licenses will continue to be subject to an administrative charge of $15 per patent, which has been made heretofore upon the grant of a license, but without requirement for payment of royalty. The new feature will

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The high magnetic performance, exceptional Q and high permeability assured by Mepham magnetic iron powders (hydrogen reduced) is daily advancing them into wider use in high-frequency, telecommunication and magnetic applications.... Strictly controlled production and attractively low prices suggest consultation with the Mepham Technical Staff.... No obligation. *Send for literature.*

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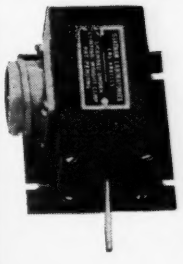

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Displacements as minute as 0.000008 in. or Force Changes as small as 0.02 oz. are readily detected by the Statham Gage without expensive electronic equipment. Complete system for remote indication or recording comprises Statham Gage, dry cells, and microammeter or recording galvanometer.

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4. Have had considerable background and training in Electro-magnetic theory.
5. Have had a few years' experience with commercial organizations as design or development engineer on radio equipment.
6. Age range preferred, 35 to 45 years.

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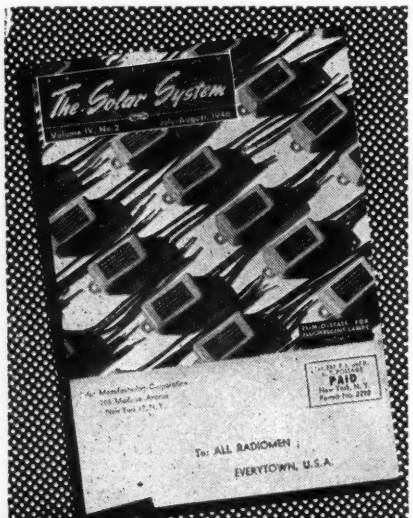

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be that such licenses granted by the U. S. Alien Property Custodian will now be open to a citizen of any adhering country. That is, products manufactured in adhering European countries, embodying such German inventions, may be imported into the United States under this procedure without restrictions based on vested U. S. patents covering such German invention.

Likewise, reciprocally, there will be no patent restriction in any adhering country to prevent the use in that country of an invention of previous German ownership, by a U. S. citizen, which would otherwise prevent a U. S. citizen from exporting to that country a device embodying the German invention. This removes what would have been a serious patent barrier to international trade in products embodying these German inventions. In some cases, tariff laws provide for the exclusion of products infringing domestic patents, without opportunity to litigate the validity of the patents.

Other countries which participated in the conference were Australia, Belgium, Canada, Czechoslovakia, Denmark, Luxembourg, Norway, and the Union of South Africa. Russia did not participate.

Radar Navigator on Boston Steamer

The first excursion steamer to have the benefit of a "magic pilot," whose efficiency is as great in darkness and fog and storm as in daylight and clear weather, now is operating out of Boston Harbor. The S. S. Steel Pier, excursion steamer which daily plies the 100-mile round trip distance to and from Provincetown, has been equipped with a General Electric electronic navigator.

Raytheon Radar Navigates Tanker

Extending peacetime applications of radar, the Raytheon-equipped SS Atlantic Mariner has just ended the first test run by any ocean-going American commercial tanker equipped with radar. One of thirteen 560-foot tankers operated by the Atlantic Refining Co., the Atlantic Mariner installation emphasizes the advantages to be gained in the use of radar. Operating the tankers at an average cost of $2,400 per day, it takes a comparatively small saving in running time to cover the cost of equipment and installation.

San Francisco Radiotelephone Experiments

The Pacific Telephone and Telegraph Co. is conducting experiments in the San Francisco Bay region to determine the practicality and layout of a mobile radiotelephone service. Half-wave transmitting antennas were installed at a 500-ft. elevation atop its building in San Francisco. The transmitter will have sufficient power to reach Oakland, Berkeley, Alameda and other communities across the bay as well as towns to the south. A number of test vehicles will survey conditions. The area, with several peaks better than 900 ft. high, offers a number of problems. Operations are expected to show how many sub-stations will be necessary

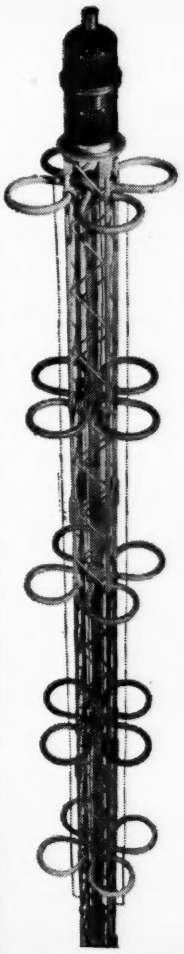
The flagpole ornament has noting to do with the coax antenna being installed for West Coast cross-bay radiophone system

for adequate coverage and whether the service meets a public requirement.

The metal sphere, shown in the picture, has nothing to do with the antenna, but is simply a flagpole ornament too familiar a landmark to thousands of residents to be scrapped.

High Titania Dielectrics

A paper on high titania dielectrics was presented by Eugene Wainer at the Eighty-ninth General Meeting of the Electrochemical Society at Birmingham on April 11-13. The properties of titania and its



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You'll be in clover when you get your new 54A CLOVER-LEAF FM broadcast antenna! Bell Telephone Laboratories designed it with lots of important features. Here are twelve of them—look 'em over:

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2. Circular azimuth pattern.
3. Simple to install.
4. Minimum maintenance.
5. Exceptionally rugged design.
6. 50 KW power capacity.
7. No multiple transmission lines.
8. No phase correcting lines or networks.
9. No balancing lines.
10. No field or factory antenna tuning.
11. No insulators—full lightning protection.
12. No end seals.

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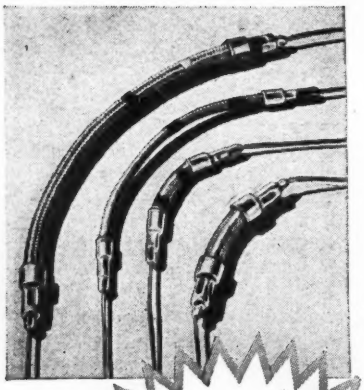

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★ Exclusively Clarostat! These flexible glass-insulated wire-wound resistors spell *tougher* components for *tighter* spots. Fibre-glass core and fibre-glass braided covering. Nothing to char or burn. Self-supporting when soldered in place. Especially handy for point-to-point wiring. Ideal for attenuators or step-by-step controls. Truly midget power resistors.

In two ratings: Series FXG, 1 watt per winding inch; Series FYG, 2 watt.

Maximum resistance per winding inch: Series FXG, 750 ohms; FYG, 1500 ohms.

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Both types supplied to any reasonable length.

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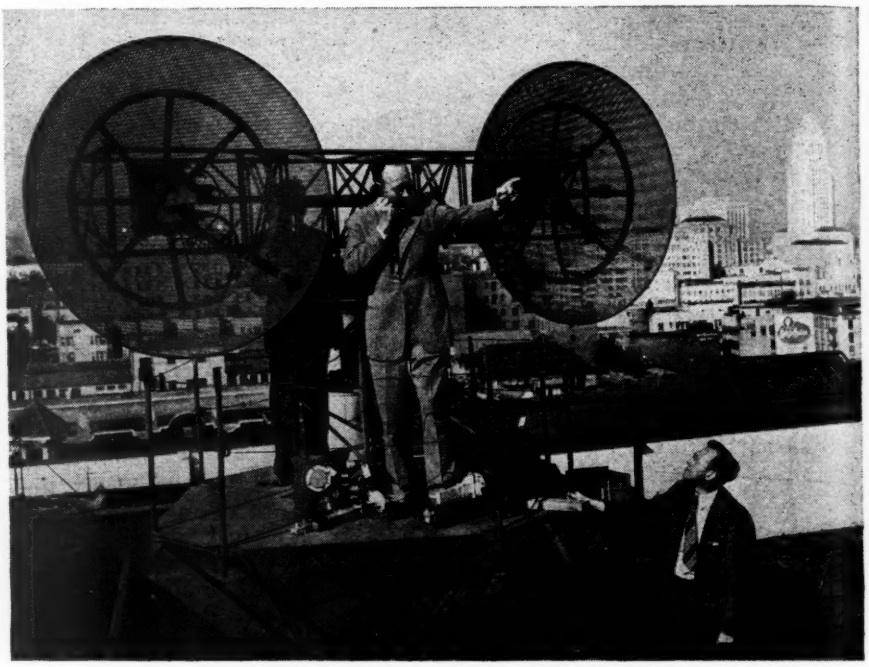

Receiving and transmitting antennas for the Los Angeles-Catalina Island UHF system

compounds, frequently used as substitutes for capacitor grade mica, were discussed. Widespread applications are made possible through the variables that can be introduced in a synthetically prepared product. Electrical characteristics of these materials, their compositions, methods of manufacture, and commercial applications were described. An attempt was made to explain the reason for obtention of the electrical properties involved and particularly the effect of various additions. Correlations between this explanation and experiments were given.

Coating for Glass Transmits Electricity

A revolutionary development in glass research, revealed by Pittsburgh Plate Glass Co., involves use of a transparent coating, called Nesa, that conducts electrical current. The coating makes it possible to heat the entire area of a panel of glass, as in a windshield, for example, thus preventing the formation of ice on the outside or fog on the inside. The coating may find additional uses in electrical equipment; it does not affect visibility through the glass.

FM TRANSMITTER PRODUCTION LINE

General view in the Newark (N. J.) plant of Federal Telephone and Radio Corp.

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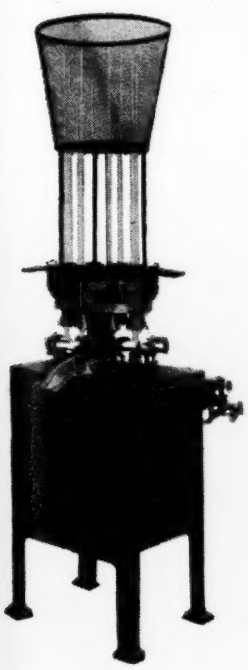

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Automatic throughout.

Can be synchronized with automatic Stem machine.

Accommodates eight full lengths of glass tubing.

Cuts off and flares in one operation.

Production, 1000 flares per hour.

Made in two sizes: *Miniature machine*, for miniature flares and fluorescent starters, and *Standard machine* for standard size lamps, fluorescent and radio tubes.

Range of *Standard Machine:*

Glass tubing	35 to 42 gauge
Length of flares	5 mm to 80 mm
Forms flares up to	47 mm diameter
Net weight	1500 pounds
Boxed	1700 pounds

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We also have available for immediate delivery a complete selection of G. E. Switchettes, Micro-Switches, and selenium rectifiers suitable for relay operation and other D. C. applications.

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Condensers	Wire-Cable	Transformers
Resistors	Transmitting Tubes	Volume Controls
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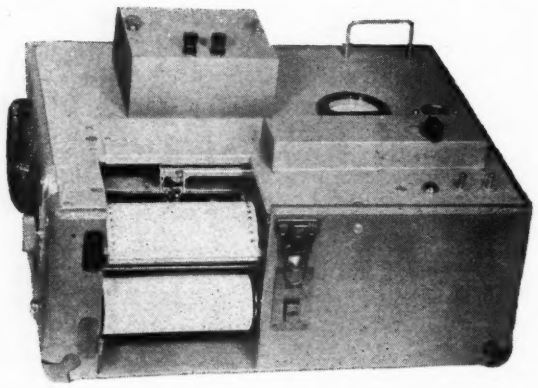

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Designers and Manufacturers of Graphic Recording Instruments and Accessories.

WTCN'S FM ANTENNA

Foshay Tower (Minneapolis) topped by 8-element square loop FM antenna, manufactured by Federal Tel and R Corp., for 3 kw radio station WTCN

New Tele Film

A new type of motion picture film especially for use in the production of pictures to be transmitted by television has been developed by E. I. duPont de Nemours and Co., Inc., Wilmington, Del. The film has a special emulsion designed to give greater detail in both highlights and shadows. NBC's New York WNBT used the film for the first time July 15 in telecasting pictures of a Washington ceremony, the reel being flown to New York for the purpose.

West Coasters Plan Electronic Trade Show

West Coast electronics manufacturers are planning for their second annual trade show which is scheduled for Los Angeles October 18-20. Affair is to be staged in the Elks Temple building and it is expected that 113 exhibits will be arranged. D. D. Durr is show director and the Tabery Corp., 3443 South Hill street, is managing the function.

Tube Data

A folder of catalog sheets giving complete technical data on a dozen of its Gammatron tubes (general and special purpose triodes, beam pentodes and rectifiers) has been issued by Haintz and Kaufman, Ltd., South San Francisco, Cal. Included are circuit diagrams and suggested operating data.